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## UNIVERSITY AND TECHNOLOGICAL INSTITUTE

IF it were generally recognized that, for the technicians required in a modern State in very great numbers, technical training is all that is normally essential, and that even for some professions no more than technical training is necessary, we should be much nearer a generally acceptable solution of the problem of the right balance between the universities and the technical colleges. Such technical training is not the function of the universities, and will continue to be given by the technical colleges and other professional or specialized institutions independent of how far they contribute also to technological education. The question as to what technological studies meet the criteria that have been suggested for university courses must be left to the universities themselves to determine; but whether such education is given by university departments or by institutes of technology it must be recognized that such courses have the character of university courses in respect of the intellectual discipline they demand. There can be no suggestion that the degrees or diplomas obtained on completing such courses are in any way inferior to those obtained as the result of study in the more academic fields at a university.

Once that is made clear, there should be little danger of serious disagreement. Contributors to a discussion on this issue in *The Times* arising out of a report of Sir John Anderson's speech at the Foundation Day celebrations of the University of London on November 25 were all concerned that the study of technology should be based on the best teaching of fundamental science, and that there should be no creation of technical colleges less well endowed and less self-governing than a university. As Lord Eustace Percy pointed out, to propose the foundation of an institute of technology on the Massachusetts or California model, or a Technische Hochschule on the Continental model, is to propose the foundation of a university, and it is significant that the German Commission on University Reform discusses this subject under the title "Technical Universities". The broad argument of that section of the report may be appropriately recalled here. It is argued that such universities have the same type of constitution and organisation as ordinary universities; research and teaching are closely associated; the task of education in its specifically academic character is the same for both; and both have the task of providing a sound professional education, though for the technical universities, professional training stands in the foreground. While universities must take account of technology in their research and teaching, the technical universities must weave technical subjects into a general structure of Western humanistic thought, and the German Commission recommends that this should be done by adding a new humanistic-sociological faculty. The Commission recognizes, too, that a beginning must be made in the secondary schools if the essentials of the spiritual heritage of the West

are to be transmitted to technical students, and it accepts the view that the technical universities have an almost greater interest than the universities themselves in a reform of the whole educational system.

These views are not without their bearing on the whole question of the training of technologists in Great Britain also. If we are to avoid the narrow specialism and to inculcate the wide outlook which is universally desired in the technician and technologist as well as in the academic graduate, a beginning must be made in the schools: the whole task cannot be left to the universities, still less to the technical colleges and institutes of technology. That in itself might be a first step towards the modification of university courses and the freeing of the universities, as Sir John Anderson said, from duties which could with greater advantage be undertaken by other types of institution. It should be remembered, too, that even if the technological faculties were entirely divorced from the universities, the overcrowding which threatens the maintenance of standards would not necessarily be removed, for less than one-seventh of the university students of Great Britain are studying applied science in some form.

The question of where technological education is best conducted is, in fact, to be decided on practical grounds, once regard has been had to the fundamental questions of the extent of the demand and the criteria for university and technological courses. The cost of equipment and of the conduct of technological research and the best means of budgetary control are important factors, as Prof. A. R. Ubbelohde has indicated, in determining whether to create a series of new institutes or expand, or create new, university departments. Questions of staffing are also important. Above all, it is imperative not merely that there should be the closest possible relations between the universities and the institutes of technology and technical colleges, but also that development and expansion should be planned under the guidance of a single authority like the University Grants Committee, which will take a national rather than a sectional or local view. Such a body can make the most effective representations to secure that the secondary education system also is adapted to assist in supplying the country with men and women of the wide and tolerant outlook and understanding which are now required in its scientific workers, technologists, technicians and other professional workers.

Prof. L. L. Oliphant, in his article on "University or Institute of Technology?" in the *Universities' Quarterly*, expresses his conviction that the applied sciences as at present taught and developed are out of place in a university. He finds it difficult to reconcile his idea of a university—its mission "to guard jealously scholarship and knowledge and to preserve the freedom to gather fresh knowledge as and where inspiration comes"—with the type of vocational training usually given in the various branches of engineering and technology. The attempt to teach engineering in a university is regarded by him as unrealistic, for no university can hope to possess equipment which is adequate for the purpose or which remains up to date and is in line with that used in industry. That might be remarked of most technical colleges as well; and for the increasing application of science and the scientific method to industry and to the human problems associated with a high level of production, we must look less to the universities as such than to separate institutions, possibly attached to the universities, or to industry itself, where applied science can be added to a sound background of fundamental knowledge.

The provision of institutions devoted primarily to the practical aspects of applied science, loosely attached to universities and located on or near the university sites, would obviate some of the difficulties which attend the teaching of applied science inside the universities and provide a healthy climate for the proper development of both higher education and research in the technological field. Institutions of the character conceived by such protagonists as Lord Eustace Percy, Lord Cherwell, Sir Ernest Barlow, Prof. Oliphant, Sir John Anderson and others and where instruction is given in the way advocated by Mr. Eric James, highmaster of the Manchester Grammar School, would be essentially universities themselves. They should be able to supply the nation with technologists in no way inferior in the width of their outlook to those who receive the more academic training of the universities. The provision of quantitative data on the probable demand for specific categories of professional men and technologists, as are given in the series of brief reports on the present and future supply and demand "for persons with professional qualifications" being issued by the Ministry of Labour and National Service, should at least make it possible to plan the consolidation of university expansion with the development of technological education and of the technical colleges. By such means it should be possible to ensure both the maintenance of university standards and the efficient use of resources of equipment and trained man-power; and also to provide the men and women upon whose efforts and ability the maintenance of the material and intellectual standards of life in Great Britain depend.

## CENTENARY OF THE SECOND LAW OF THERMODYNAMICS

### Thermodynamics

**An Advanced Treatment for Chemists and Physicists. By Prof. E. A. Guggenheim. (Monographs on Theoretical and Applied Physics, Vol. 2.) Pp. xxiii+395. (Amsterdam: North-Holland Publishing Co., 1949.) 20 f.**

IT is almost exactly a hundred years since what is now known as the second law of thermodynamics was formulated. The honour of first making the general statement that "heat cannot of itself pass from a colder to a hotter body" falls to Clausius, in a memoir of which the substance was communicated to the Berlin Academy of Sciences on February 18, 1850, and which was published in *Poggendorff's*

*Annalen* in April and May 1850. More than one attempt was being made to reconcile Carnot's theory of the heat engine with the newly discovered equivalence of heat and work. Helmholtz had enunciated the first law or principle of the conservation of energy a few years before. W. Thomson (Kelvin) had become acquainted with Carnot's memoir while in Paris several years earlier, and in 1849 had published in the *Transactions of the Royal Society of Edinburgh* a lengthy description of the Carnot cycle; but he failed at this time to discover the general relation or to recognize that the work obtained is the difference between the heat taken in and that given out.

This was clearly understood by Clausius. "It is not even necessary to cast the theory of Carnot overboard," he says. "On a nearer view of the case we find that the new theory is opposed, not to the real fundamental principle of Carnot, but to his addition 'no heat is lost', for it is quite possible that in the production of work both may take place at the same time; a certain portion of heat may be consumed and a further portion transmitted from a warm to a cold body and both portions may stand in a certain definite relation to the quantity of work produced."

W. J. M. Rankine had arrived at similar results in a memoir "On the Mechanical Action of Heat", which was read to the Royal Society of Edinburgh on February 4, 1850. He says: "No mechanical power can be given out in the shape of expansion unless the quantity of heat emitted by the body in returning to the primitive temperature and volume is *less* than the quantity of heat originally received . . . the sum of the *vis viva* in the two forms continues unchanged". Rankine's ideas were based on a rather special theory in which heat was regarded as due to the rotation of atomic vortices and do not therefore have the generality of Clausius's treatment, but he does give 'a thermodynamic function' which was later named entropy.

Thomson's mind was evidently working on similar lines and, a year later, in 1851, giving the fullest priority to Clausius and Rankine, he published the first part of his memoir "On the Dynamical Theory of Heat", in which the second law is stated in the words: "It is impossible, by means of inanimate material agency, to derive mechanical effect from any portion of matter by cooling it below the temperature of the surrounding objects". In the following year (April 19, 1852) he read to the Royal Society of Edinburgh his paper "On a Universal Tendency in Nature to the Dissipation of Mechanical Energy", in which the second law appears in its fullest generality:

"1. There is at present in the material world a universal tendency to the dissipation of mechanical energy.

"2. Any *restoration* of mechanical energy, without more than an equivalent of dissipation, is impossible in inanimate material processes, and is probably never effected by means of organised matter, either endowed with vegetable life or subjected to the will of an animate creature.

"3. Within a finite period of time past, the earth must have been, and within a finite period of time to come the earth must again be, unfit for the habitation of man as at present constituted. . . ."

It was thus Thomson's particular contribution to see the universal consequences of the law. As Helmholtz said later in one of his popular lectures, "We must admire the sagacity of Thomson, who in the letters of a long-known little mathematical formula, was able to discern consequences which threatened the universe, though certainly after an infinite period of time, with eternal death".

To complete the story, in 1865 Clausius arrived at the alternative general formulation: "The energy of the Universe is constant: its entropy tends to a maximum"; and ten years later Gibbs deduced in great detail the consequences of this, as applied to the equilibrium of heterogeneous systems.

A long period followed in which many of the results obtained by Gibbs were rediscovered piecemeal by the use of painfully 'eccentric cycles' and a cumbrous apparatus of pistons, cylinders and semipermeable membranes. The establishment of accurate methods of determining thermodynamic functions of actual systems was due to a great extent to the work of G. N. Lewis and his school in the early years of this century. The main progress since then has been the correlation of the thermodynamic and statistical approaches to equilibrium which has been achieved and systematized by Darwin, Fowler and Guggenheim, and the elucidation of: (*a*) the low-temperature phenomena which were originally described in Nernst's third law of thermodynamics, but as is now well known are only satisfactorily described in terms of the statistical method, and (*b*) the entropy constants of gases.

All these developments are fully discussed in the monograph which provides the occasion for these remarks, which is one of the most comprehensive accounts of 'classical thermodynamics' which has ever been written. It is described as "an advanced treatment . . . written for graduates". The assumption of previous knowledge permits Prof. Guggenheim to plunge at once into the subject in a completely logical and non-historical fashion, rejecting the use of what he describes, in G. N. Lewis's phrase, as "cyclic processes limping about eccentric and not quite completed cycles". Students who have acquired the necessary preliminary equipment, which permits them to study the subject in its most abstract and general form, will find it an admirable guide. At first sight it may appear to be severely mathematical, but the mathematical difficulties are more apparent than real, and any student who has the patience to study the subject thoroughly will find in this book a lucid guide in which, unlike in most other treatises, the emphasis is on first principles, and the logical basis is always stressed and frequently illuminated.

If the book has a fault it is in being too comprehensive. It leaves little to the student, who will rarely have the fun—which so many of us have experienced—of discovering relations which are later found to be in Gibbs or elsewhere. In the presence of so much excellence, it would be ungenerous to quibble over small points; but the writer may perhaps be permitted to express the hope that Guggenheim's naming of the principle that "if two systems are both in thermal equilibrium with a third system, then they are in thermal equilibrium with each other", as the "zeroth principle of thermodynamics" will not be generally adopted.

The book is beautifully produced, and though its appearance at this time is, no doubt, a coincidence, it is, in fact, a timely memorial, since it offers a reasoned and critical account of the results of the first hundred years of the laws of thermodynamics.

J. A. V. BUTLER

## ESSAYS ON HUMAN AFFAIRS

### Creative Man

And other Addresses. By Viscount Samuel. Pp. vii+141. (London: Cresset Press, Ltd., 1949.) 9*s*. 6*d*. net.

THROUGH almost all the addresses which are here collected under the title "Creative Man" runs one theme very similar to that which inspired Lord Samuel's Messel Lecture, "Science and Civilization", in July 1940. Here again are the conception of the whole welfare of man in all its fullness, spiritual and intellectual, individual and social, the same appreciation of the importance of research, its encouragement and rightful use, the clear realization of the limitations as well as of the values of science, the emphasis on individuality and freedom, and the conviction that means matter as well as ends, and that while the material cannot be allowed to dominate, it must not be ignored. Man's supreme need is for a moral basis of society, a loftier ethic, fostering thought and learning, and bringing tranquillity and peace.

To the question whether our will can rise to match our opportunity, Lord Samuel gives no more decided answer in these later addresses than in his earlier lecture. He claims to be neither optimist nor pessimist but, quoting George Eliot's answer, regrets that the term meliorism, meaning that, on the whole, things are better now than they have been in the past and might be better still in the future if we made the necessary effort, has not come into common use. Lord Samuel's mind is occupied with the need for a drawing together of philosophy, science and religion in order to offer the world a way of escape, as is brought out particularly in his Romanes Lecture (from which the book takes its title), or in that on science and philosophy, delivered before the British Association, and in his presidential address to the Royal Institute of Philosophy in October 1948, "Decline or Revival of Religion".

This last-named address, with the short broadcast on Francis Bacon, given in 1947, is the only material printed here for the first time; but the addresses read now with the same charm and persuasiveness as when they were delivered, and some of their observations are even more needed. In 1941, in his Herbert Spencer Lecture entitled "Democracy: its Failings and its Future", Lord Samuel said: "There are things that matter more than good administration—liberty matters more, and social justice; and these depend largely on the kind of government that there is". The truth of that observation has been emphasized by much hard experience, even in the world of science, in the past eight years. In the same lecture, urging that the State should try more to make public service easy, Lord Samuel anticipated an important point made by Lord Beveridge in his report on "Voluntary Action" and which is exercising the minds of all concerned with the future of local government, for example. Again, his definition of liberty as that men should be free to do what they will, only provided that they do not interfere with the equal freedom of others, is reflected in current discussion on human rights, just as its elaboration into the general principle that we should tolerate everything except intolerance and that liberty should suppress nothing except attempts at its own suppression anticipate an important argument of Mr. Middleton Murry in "The Free Society".

Delivered to diverse audiences, these addresses read well. They seem to retain something of the perennial freshness of the Elizabethan thinker and essayist to whom in one of them Lord Samuel pays tribute. If indeed this volume contains Lord Samuel's final word, its mellow wisdom, magnanimity and easy diction make it a charming valediction.

R. BRIGHTMAN

## BRITISH MAMMALS

### Mammals in Britain

By Michael Blackmore. Pp. 128 (77 plates). (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 15*s*. net.

MICHAEL BLACKMORE has written an enjoyable book on mammals in Great Britain and has gathered, from various sources, a remarkable collection of photographs, some of great beauty. One of the most notable is that of a blue hare half hidden in its snow tunnel; this photograph was, I believe, taken in Strathspey. We are told interesting facts about British mammals, some of the animals being extinct. We know that the brown rat is an undesirable immigrant, but most of us were under the impression that the black rat, the old English black rat, as it is often called, is a firm resident. Yet we now learn that it also is an alien; for, writes the author, "it probably arrived in the thirteenth century". He states that rabbits probably existed in Britain in prehistoric times; but the race disappeared during the glacial period. He considers that the present rabbit stock probably dates from the twelfth century. The grey squirrel was introduced in 1889.

In England the bear was exterminated before the tenth century. Tradition, Mr. Blackmore states, records that the last bear was killed in Scotland in the year 1057. The Norse name for bear occurs in Bernera—the name of several islands of the Outer Hebrides. It is possible that these place-names commemorate actual bears during the Norse occupation of those islands, which began in the ninth century and lasted until 1263; but the Celtic scholar, the late Prof. W. J. Watson, inclined to the belief that here the word Bjorn, a Bear, was a man's name. We learn that reindeer (there is now talk of re-introducing them on a peninsula in the west of Ross-shire) were still in Scotland towards the close of the twelfth century. Perhaps the last beaver record is in the year 1188, in Wales. Wolves survived in the Scottish Highlands until the seventeenth century; tradition avers that large areas of the Old Caledonian Forest of Scots fir were burned to drive out the wolves. On p. 23 the author states that the hedgehog is easily tamed, and records one which used to snore contentedly by the kitchen fire. The dog of the house at first disliked the hedgehog, but later the two became friends.

There is an interesting chapter on British bats, of which there are twelve species. On p. 27 the author discusses the theory that bats in flight avoid obstacles by a form of radar. Writing of those rare mammals, the marten-cat and the polecat, he makes the interesting statement (p. 48) that the only flesh-eating mammal protected by law in Britain is the Atlantic or grey seal. It seems time that the rare marten should also be given protection. SETON GORDON

## Les molécules géantes et leurs applications

Par Georges Champetier. (Bibliothèque d'éducation par la science.) Pp. iv+459. (Paris: Albin Michel, 1948.) 720 francs.

"MANY of the polymers being examined to-day have been obtained in the past; but the workers who made them did not call them polymers. They called them something quite different and threw them down the sink." This remark, made by Dr. A. S. C. Lawrence in *Science Progress* in 1934, finds an echo in the introduction of M. Georges Champetier's book. The curious reader of chemistry will find ample reason in this book for the scientific world's altered attitude to macromolecular materials, in spite of certain qualities that they have which are repulsive to a truly refined organic chemist. The book is not intended for the hardened polymer expert; for it is extensive rather than intensive. It gives no references to original papers; instead there is a bibliography of more specialized books (from which Staudinger's historically fundamental "Die Hochmolekularen Organischen Verbindungen" is a rather notable absentee).

But M. Champetier's book is remarkably comprehensive in scope. Part 1 describes the general constitution and properties of macromolecular compounds, covering, *inter alia*, the estimation of their molecular weights, investigation by X-ray and other physical methods, their chemical properties, swelling and colloidal properties, and mechanical and physical properties. Part 2 deals, in turn, with a large number of individual polymers, starting with inorganic macromolecules (including carbon, phosphorus, sulphur and crystalline materials, as well as the silicones), going on to organic polymers, vinyl, rubber-like, polycondensed, multi-dimensional, and drying oils; and closing with an account of biological macromolecules—carbohydrates and proteins. The whole furnishes an informative survey of the scientific aspects of polymers, without losing sight of their technical uses. G. W.

## Comparative Anatomy

An Introduction to the Vertebrates. By Leverett A. Adams and Samuel Eddy. Pp. vii+520. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 30*s*. net.

THIS text-book of comparative anatomy is an expansion of Prof. L. A. Adams's earlier work on vertebrates. With the assistance of Prof. S. Eddy he has rearranged the material, added to and corrected the text, and incorporated new facts and ideas. The result is a readable and informative book, suitable for advanced students of the post-intermediate grade. The first five chapters make up Part 1, and contain a systematic review of the vertebrates and a short chapter on their embryology. The second part, with twelve chapters, deals with a comparative study of the systems of the body and is orthodox in treatment. There is a good bibliography. A glossary of zoological terms has been added, and the index is adequate.

The illustrations are clear and well chosen, especially those by K. H. Paul, and the plain lettering might be imitated with advantage in text-book illustrations in Great Britain. Some figures, however, are not so reliable. For example, no size or magnification is given in the sketches of animals in the first part of the book, and the student may infer that *Neoceratodus* is smaller than the frog, and *Archæopteryx* larger than the cassowary. In the diagrams of the vascular system of the frog (Fig. 244), the pulmo-cutaneous artery is wrongly drawn on the dorsal side of the aortic arch, and this is repeated in Fig. 247 for the reptile. In Fig. 245, for post-cardinal read post-caval, and in Fig. 258 the precaval system is that of the Urodele and not of the Anuran, though the diagram is labelled frog. Why are the large dorso-lumbar veins omitted from all these figures? With these and a few minor corrections in the text, the book can be recommended. Production and printing are excellent.

## Functional Localization in the Frontal Lobes and Cerebellum

Being the William Withering Memorial Lectures delivered at the Birmingham Medical School, 1948. By Dr. John F. Fulton. Pp. xii+140. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 15*s*. net.

THIS, the reporting of the William Withering Memorial Lectures in monograph form, has made available a concise, very readable and up-to-date exposition on what are the functions of the frontal lobe. This—coming as it does from one of the world's foremost experimental neurophysiologists—has the stamp of authority.

The author pays tribute to the pioneer work of Yerkes for his animal-training experiments; also to Victor Horsley and Harvey Cushing for the foundation of the neurosurgical approach. He discusses neurosurgery in its efforts to treat emotional states and the chance discovery of its relief of intractable pain. He believes that with increasing research work, the operation of lobotomy will become much more selective and thereby reduce the undesirable destruction which occurs at present.

The last part of the book is devoted to the cerebellum reconsidered, and points out that, with modern investigation, localization in this part of the brain is highly developed. The debt modern knowledge owes to the technique of physiological neuronography begun by De Barenne is acknowledged.

This fascinating book should be read by every student of neurophysiology, whether he be laboratory worker, clinician, psychiatrist or neurosurgeon. A very complete bibliography is appended to each section of the book.

## A History of Oto-Laryngology

By Dr. R. Scott Stevenson and Dr. Douglas Guthrie. Pp. vii+155+30 plates. (Edinburgh: E. and S. Livingstone, Ltd., 1949.) 17*s*. 6*d*. net.

THE immediate stimulus for the writing of this interesting book was the International Congress of Otolaryngology in London in 1949. The text is fascinating, most especially to those who practise the speciality, but it should prove of great value to those interested in medical history generally. One finds that two of the most important discoveries in the development of the speciality owe their origin to the work of a postmaster and a singing teacher.

The illustrations are well chosen and show that much research has gone into the development of this small, quite readable book.

The chapter on education of the deaf is full of information which should appeal to the social worker and educationist.

The bibliographical details at the end of the book are very adequate.

## Human Relations in Modern Industry

By Dr. R. F. Tredgold. (Social Science Studies.) Pp. 192. (London: Gerald Duckworth and Co., Ltd., 1949.) 8*s*. 6*d*. net.

IT is recognized by all who hold responsible positions in industry that the biggest industrial problem to-day is not technological but human. In the drive for productivity a great deal of thought is being given to the means of making all work more effective rather than more arduous. The methods used include schemes to enable management and workers to work for the common purpose of the greatest possible efficiency in the particular industry. Out of these schemes has grown the study of what is popularly called human relations in industry and, in this book, R. F. Tredgold discusses those factors which he believes will make for friendly spirit and concerted effort by both sides in industry. His suggestions are based on a series of lectures which were given at the Roffey Park Rehabilitation Centre and where he himself, in his capacity as psychiatrist, was able to re-orientate the attitudes of many industrial workers whose emotional balance had become upset.

Tredgold's ideas are put forward in no dogmatic way and stand almost as subjects for discussion similar to those thrown out at Roffey Park. His psychological analyses of behaviour, why people work, the essentials and teaching of leadership contain little new or original, but the book has value in presenting current ideas on human relations in industry in a clear, positive and interesting way. The author is happiest when dealing with such topics as the significance of neurosis in production, early signs of mental disorder and problems of individuals, and for these chapters alone the book merits study by industrial executives and others whose work involves getting the best out of people with whom they have to work. T. H. H.

## Industrial Rheology and Rheological Structures

By the late Henry Green. Pp. xii+311. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 44*s*. net.

THE late Henry Green was best known to older rheologists for his work with E. C. Bingham in the early twenties and to younger people for his quite recent contributions, in collaboration with Miss R. Weltmann, to the theory and measurement of thixotropy. During the intervening period, he published little on rheology. Time will probably show that his main contribution lay in his insistence that, wherever possible, rheological phenomena should be followed under the microscope. In many cases, rheological theory has to account for behaviour at a molecular level; but there are occasions when the structural units are of microscopic size, and Green rightly insisted on making use of this fact whenever possible. Consistent with this liking for direct observation was his extremely practical attitude to rheology as a discipline. In this posthumous book he tells the reader very directly that his aim is "to give the laboratory man a workable rheological system", and he has appendixes "for the laboratory investigator" and "for the laboratory director" which are full of sound common sense.

The book is described on the cover as "A manual and practical working guide", but in this capacity it must be viewed with caution. There are too many errors and inexactitudes for it to be a reliable source of information for those unfamiliar with rheological theory. This is particularly true of the glossary, in which the definitions of such terms as elastic deformation, laminar flow, specific viscosity and stress are definitely misleading. The treatment of tack, also, is very much over-simplified. The book describes in some detail that part of rheology of special interest to the author, and could only serve as a "practical working guide" if read in conjunction with other books covering a wider field from which the information given could be checked and amplified.

G. W. Scott Blair

## Quantitative Analysis

By Prof. Willis Conway Pierce and Prof. Edward Lauth Haenisch. Third edition. Pp. xiv+520. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1948.) 22*s*. 6*d*. net.

THIS is a student's text-book designed for a one-year course of laboratory work in volumetric and gravimetric analysis. Each section is introduced by a discussion of theory and general principles. Detailed experimental instructions are given, followed in each case by explanatory notes. A number of questions and problems are provided at the end of each chapter.

More than half the book is concerned with volumetric methods, and most of the more familiar of these are described, including the use of oxidation-reduction indicators and electrometric end-points. Gravimetric processes are then introduced, culminating in the complete analysis of a limestone and a brass, a determination of copper by electrodeposition being included. The experimental methods described are up to date, and due attention is given to the assessment of errors and their origin. The book concludes with a chapter on the use of the original literature and a bibliography of reference works.

The work of the college lecturer will be considerably lightened by the use of this volume, which provides an excellent and stimulating guide for the student.

## Bird Life

By Edward A. Armstrong. Pp. xi+152+26 plates. (London: Lindsay Drummond, Ltd., 1949.) 12*s*. 6*d*. net.

EDWARD ARMSTRONG has already made a name for himself as an able writer on birds and bird matters, and this latest volume from his pen, "Bird Life", will enhance his reputation for charm combined with accuracy. He covers a wide field: such diverse matters as migration, defying foes, the "Language of Birds", deluding enemies, and birds and men, are some of the many topics he deals with.

Under the heading of "Deluding Enemies", the author has some interesting remarks to make on the "injury-feigning" behaviour of birds. He says: "'Injury-feigning' in many birds seems to have arisen as 'betwixt and between' behaviour, when the bird wanted to flee and also wanted to look after the eggs or young. In the fable, Buridan's ass died because it could not decide which of two exactly equal piles of hay to eat. It seems in the past birds sprawling about, due to the conflict of mother-love and fear in their hearts, accidentally decoyed animals away from their nests and so left more descendants than those which fled leaving their treasures at the enemy's mercy or remained to be seized on the nest. So 'injury-feigning' behaviour became fixed and inherited."

Mention must be made of the excellent photographs that illustrate this book and the many delightful drawings by Dr. Ennion. Frances Pitt

# THE AUSTRALIAN NATIONAL UNIVERSITY

## A PROJECT IN RESEARCH

By Prof. DOUGLAS B. COPLAND
Vice-Chancellor of the University

On October 24, 1949, the ceremony took place in Canberra of laying the foundation stones of the first three main buildings of the Australian National University. The Prime Minister (the Right Hon. J. B. Chifley) laid the foundation stones of the John Curtin School of Medical Research (so named in honour of the former Prime Minister) and the Research School of Physical Sciences, and the Minister for Post-War Reconstruction (the Hon. J. J. Dedman) laid the foundation stone of University House, a residential college designed to combine features of the English college and the American faculty club. Mr. Chifley and his colleague Mr. Dedman have given great support to the establishment in Canberra of a university at the postgraduate level on lines that mark a departure from the traditional development of universities in the younger countries.

Naturally, the ceremony of laying foundation stones was preceded by much planning. The new University derives its authority from an Act of the Commonwealth Parliament passed in 1946 and providing for both undergraduate and graduate work. There is in Canberra a small but developing University College affiliated with the University of Melbourne which may under the Act be incorporated by the Australian National University. But the Act also provides that the new University may develop graduate studies and research and mentions in particular four Schools, namely, Medical Research, Physical Sciences, Social Sciences and Pacific Studies. It is in these four Schools that the University will concentrate its efforts in its early years; no action will be taken to incorporate the College or to develop undergraduate work until the research schools are fully established.

The Act provides for a Council to manage the University much on the lines of that of a provincial university in the United Kingdom or the universities already established in Australia; but the Council will not be established until the University has a convocation of at least fifty members from which to elect a proportion of the Council. Meanwhile, there is an Interim Council appointed by the Governor-General in Council, but selected so as to give a reasonable balance among academic, official and parliamentary members. The Interim Council has nearly all the powers of the duly constituted Council, and is free to manage the affairs of the University within the wide terms set by the Act. Its first decision was to concentrate upon the work of the four Research Schools already mentioned. The Act provides that after July 1, 1951, a sum of £325,000 will be made available annually for the current expenses of the University, and the Interim Council has laid its plans to absorb the whole of this grant in developing the four graduate Research Schools and the accessories necessary for them, including the establishment of a National University Library. Separate financial provision has been made for the building of the necessary laboratories, the residential college and the beginnings of the library. The residential college (University House) has already been commenced on the site in Canberra, and building operations are about to start on the laboratory for the Research School of Physical Sciences, while the plans for the School of Medical Research are at an advanced stage. The Library is being collected in its first stages in Melbourne, and will later be transferred to Canberra.

The site is an area of some 250 acres in the heart of Canberra, on perhaps the most attractive situation in the developing capital city. Some office buildings are already on the site, and a few houses. These buildings will gradually be made available to the University for administrative offices, temporary library accommodation and working accommodation for the Research Schools of Social Sciences and Pacific Studies. The building plans are being developed with an eye to the future, and in the long run all the existing buildings will be replaced by new construction specially designed for university purposes and consistent with the architectural requirements of a modified early Colonial design. The founders of the University will see only the beginnings of the master plan, and the best they can hope for is that they will not be accused by the generations to come of lack of imagination in the basic design or the magnitude of their plans.

Emphasis on research does not mean that the University will be without a vigorous student body. It will have a group of graduate scholars selected on grounds of proved competence in scholarship, and working for their doctorate degrees. The ratio of student scholars to staff, however, will be much lower than in the normal university, even where post-graduate studies predominate. In the early years there will be no undergraduates; and if later there is provision for undergraduate teaching, it will not interfere with the work of the Research Schools. These are designed to combine research at a high level with the training of research scholars. The permanent staff is to consist of the Directors of the Research Schools, probably five Professors in each School, and a group of Readers and a few permanent Fellows. At the other end will be the graduate scholars, drawn, it is hoped, from the graduates of overseas universities as well as of the Australian universities. In between will be two grades of research fellows, designated Research Fellow and Senior Research Fellow. They will be awarded fellowships, in each case for three years and renewable for two more years on the ground of special competence in research; but it is not intended that they should remain as permanent members of the staff or workers of the University, except in the few cases where they may succeed to readerships or professorships. It is expected that these Research Fellows will be given the opportunity of pursuing their researches under suitable conditions, will participate in the training of the graduate scholars, undertake some lectures or seminars in the other universities, and on completion of their work will be available for

higher positions in other universities or in research institutions. They will be a vital force in the University, and it is important that there should be a regular inflow of them. They will have a stimulating effect on their seniors as well as their juniors.

The question may be asked: Why a National University? The main answer is to be found in the increasing interest of the Australian Commonwealth Government in applied research through the Commonwealth Scientific and Industrial Research Organisation, on which the annual expenditure has now reached £2 million, and in the pressing need for fundamental research. Since 1936 the Commonwealth has made a direct grant annually for research to the universities of Australia. This commenced at £30,000 and has grown now to £100,000. It is used for promoting postgraduate research in the universities and, though insufficient, it has been a great stimulus to postgraduate studies. But there was need for a more concentrated attack on higher research, that would give the best products of the universities opportunities for further training and research. This will be one of the main tasks of the National University, and its work cannot but strengthen the graduate studies of the other universities in Australia. On the undergraduate level, specialized training for administrative work is necessary in the expanding functions of the Commonwealth, apart from the need for degree courses for officers of the Government and residents of Canberra. These are being provided by Canberra University College, and will continue to be so provided; but in the long run they may be developed in the National University.

In the plans for the development of the new University the experience and guidance of established scholars operating in the four fields in which the University will commence its activities have been drawn upon. An Academic Advisory Committee in the United Kingdom has been established to act as the academic board of the University. This Committee consists at present of three distinguished Australians: Sir Howard Florey of Oxford in medical research, Prof. Marcus Oliphant of Birmingham in physics, and Prof. K. C. Wheare of Oxford in the social sciences, and of one New Zealander, Prof. Raymond Firth of London in Pacific studies. This Committee has rendered great service to the University in its early plans, and has enabled it already to gather the nucleus of a body of distinguished academic men to commence its work. Seven professors have been appointed and some are already at work, though not yet in Canberra. Prof. Oliphant has accepted the office of director of the Research School of Physical Sciences and expects to arrive in Canberra early in 1951 to commence the installation of equipment for the laboratory. Directors for the other Schools have not yet been appointed; these Schools are being developed under the guidance of the other members of the Academic Advisory Committee already mentioned. The Interim Council plans to build up gradually the permanent staff, so that when the facilities are available in Canberra it will be possible to assemble staff and scholars there without delay. This will be done during 1951, and by the end of that year the University should have a considerable academic body at work in Canberra. There will be more delay in starting work in the Medical School in Canberra than in the other Schools, because of the extensive plans and preparations required for the medical laboratory.

The scope of the work is perhaps more extensive than the definition of the Research Schools suggests. In medicine, all phases of non-clinical research will be undertaken, including chemistry, biochemistry, microbiology, pathology, physiology and pharmacology. In physics the emphasis will be on nuclear physics, but work in astrophysics and radiophysics will be developed in co-operation with other research institutes now at work in Australia. The Research School of Social Sciences will embark on a comprehensive attack on all phases of social science, including history, economics, political science, social philosophy and law. A somewhat novel feature of the work of the University will be the Research School of Pacific Studies, which will attempt a concentrated study of the political, social and international issues in the Pacific area; the specific departments of study to be organised include anthropology, Pacific history, political science, geography, demography and international relations.

In all phases of its work the new University will co-operate actively with the other universities of Australia. Its staff will be available to undertake short lecture courses or seminars in those universities, and its facilities at Canberra will be available to staff and scholars of other universities. This contact will be mutually advantageous, especially for the National University, in giving its staff experience and some obligations in teaching, without which it is doubtful whether research at a high level can be maintained. The Australian National University has already brought to Australia some distinguished scholars as visiting professors from Great Britain, Canada and the United States. These scholars have spent most of their time in the other universities, not so much giving formal lectures as meeting staff and advanced students informally, and this has proved a great advantage. It is hoped that this activity will be maintained even when the University is in full operation at Canberra.

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# FLAME SPECTRA*

By Dr. A. G. GAYDON

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THE most obvious distinction between combustion and other chemical processes is the appearance of a flame, that is, the emission of light. The study of the quantity and quality of this light—the study of its spectrum—is of interest for at least three reasons. First, the spectra obtained are of interest for pure spectroscopy; many of the band systems seem to be peculiar to flames; for example, the bands of IO, BrO, ClO and Dr. W. M. Vaidya's hydrocarbon flame bands of HCO, and their study yields information about the structure of these radicals. Secondly, information about the combustion processes themselves may be obtained; in the reaction zone of hot flames of pre-mixed gases the time in which the reactions take place may be less than a millionth of a second, and chemical sampling under these conditions is impracticable, whereas the

* Summary of a Friday Evening Discourse given at the Royal Institution on November 11. For further details of this work, reference may be made to "Spectroscopy and Combustion Theory" (A. G. Gaydon, 2nd edition, 1948) and to recent papers by Gaydon, A. G., and Wolfhard, H. G., *Proc. Roy. Soc.*, A, **194**, 169 (1948); **199**, 89 (1949); and in the press.

spectra do give some information about what intermediaries are formed. Thirdly, we learn about processes of energy transfer from one molecule to another on collision; indeed, flame spectroscopy may be regarded as a sort of inverted photochemistry—in photochemistry we use light to produce chemical reactions, whereas with flames chemical reaction gives light.

The majority of flames are rather weak sources of light, and the spectra are usually studied photographically. An oxy-acetylene flame is, however, sufficiently bright for the spectrum to be projected, and it may readily be seen that it consists of a number of bands. The Swan system of bands of $C_2$, diatomic carbon vapour, are the strongest feature, and the bands of CH in the violet are also strong. All flames of hydrocarbons pre-mixed with air or oxygen show these bands, also a strong system of hydroxyl bands in the near ultra-violet and the hydrocarbon flame-bands, these systems all being easily seen in the spectrum of an ethylene – air flame. We thus find that many active radicals are present in the combustion zone, and this knowledge has had a marked effect on the development of chain-reaction mechanisms for combustion. Hydroxyl radicals, in particular, are used in very many schemes for the combustion, although the formation of $C_2$ and CH radicals is not usually accounted for by combustion theories, despite their prominence in the spectrum.

In flames at atmospheric pressure the reaction zone, represented by the inner cone of the ordinary Bunsen-type flame, is extremely thin. For the oxy-acetylene flame the luminous zone is only 1/50 mm. thick. Under these conditions, with thin conical flames surrounded by a relatively much greater thickness of hot burnt gases, it is not possible to study the structure of the reaction zone in detail. Dr. H. G. Wolfhard has, however, found that in flames at very low pressure the thickness of the reaction zone increases, roughly inversely as the gas pressure, so that at the lowest pressures it may be a few centimetres thick, and by adjustment of the pumping speed and gas flow it is possible to obtain flat disk-shaped flames. The experimental technique is simple; the essential thing is to use adequate pumping-speed and burners of very large diameter. Dr. Wolfhard and I, in collaboration, have examined the spectra of many flames at low pressure. Using a burner of 5½ cm. diameter, flames have been obtained down to 0·9 mm. of mercury pressure for oxy-acetylene—probably the lowest pressure at which a flame has so far been maintained.

These low-pressure flames of hydrocarbons are bluish and have a fairly marked greenish base, with a top that is more blue-violet. The spectrum shows $C_2$ bands extending towards the base, and CH predominating towards the top. One might expect that in breaking up a hydrocarbon molecule hydrogen atoms would be successively stripped off, with consequent formation of CH before $C_2$. However, the new observations suggest the reverse, that is, the formation of CH after $C_2$. A reaction such as $C_2 + OH = CO + CH$ may even be possible.

Empirical and qualitative spectroscopic studies of flames can thus give us a certain amount of useful information. However, we still do not know how some of the radicals found in flames are formed, nor do we know much about the peculiar excitation processes in flames. Astrophysicists have done excellent work on quantitative measurements of the spectra of stars, despite the small amount of light available, and have determined much about the composition, temperature and motion of stars. With a controllable laboratory source, the application of such methods should enable us to deduce much about what goes on in flames, even under the non-equilibrium conditions that prevail.

In the reaction zone, where the chemical energy is being released, we cannot expect equipartition of energy among its various possible forms, and it will not be possible to define the temperature of the flame. However, it is possible in some cases to determine the average amount of energy in a particular form and so to assign an effective temperature. The emission spectra only give information about the electronically excited molecules in the flame. For a molecule the energy may be divided between kinetic energy of translation, internal energy of vibration, rotation, and excitation of electrons from the lowest orbit to orbits of higher energy. Also, in the flame the proportion of molecules which are dissociated to free atoms may be used for estimating an effective temperature for this type of equilibrium. Attempts have been made to study the effective temperatures for the various possible forms that the energy may take for the excited radicals found in flames, in the hope that it may reveal the nature of the excitation processes.

In a band spectrum, the position of the system of bands is determined by the change of orbit of the electron, while the position of individual bands within the system depends on changes in vibrational energy. When examined with spectrographs of large dispersion, each band is found to consist of a large number of individual lines, these each corresponding to different changes in rotational energy. The intensity of a line, $I$, is given by

$$I = C.P.\nu^4.\exp(-E_r/kT),$$

where $C$ is a constant depending on the exposure-time and strength of the flame, $P$ the transition probability, $\nu$ the frequency of the spectrum line, $E_r$ the rotational energy of the level from which the line arises, $k$ the Boltzmann constant and $T$ the absolute temperature. $P$, which depends on the rotational quantum numbers and the type of transitions, may be evaluated theoretically, and $E_r$ is known from the analysis of the spectrum. Thus, if the relative intensities of two or more lines are compared, it is possible to evaluate $T$, the effective rotational temperature. This has been done for several molecules in various flames. An interesting example is hydroxyl.

In the oxy-hydrogen flame the emission of the hydroxyl band at 3064 A. is relatively weak compared with that from hydrocarbon flames. A striking effect is that of the addition of a little acetylene to an oxy-hydrogen flame. The addition of only 0·75 per cent reduces the exposure-time for comparable density from 2 hr. to 6 min., and it is obvious from the appearance of the plate that the rotational structure has extended considerably, corresponding to a higher effective temperature Actually, measurement on large dispersion shows that for the hydrogen flame the effective rotational temperature is approximately the expected flame temperature. In acetylene flames, the effective temperature is high and varies with pressure.

| Pressure (mm. Hg.) | 760 | 13 | 5·5 | 2·5 | 1·5 |
|---|---|---|---|---|---|
| Effective rotational temperature (°K.) | 5,400 | 5,700 | 6,200 | 7,000 | 8,750 |

These results may be explained by assuming that the hydroxyl radical is formed chemically in the electronically excited state, with high rotational energy as well. At very low pressure there is no collision deactivation, so that the observed temperature is very high. At high gas pressure there is collision deactivation, and then there is competition between loss of the electronic excitation (which can happen rather infrequently, but, when it does happen, it is of course complete) and loss of rotational excitation (which happens more readily, but probably only by a little at each collision). Approximate calculations indicate that on the average the excited hydroxyl radical survives about a hundred collisions before losing its electronic energy, and that during these hundred collisions the loss of rotational energy brings the effective temperature down to about 5,400° K. The formation of excited hydroxyl at high rotational energy requires a highly exothermic process. A possible reaction is $CH + O_2 = CO + OH$. If we assume a high value for the dissociation energy of carbon monoxide (the value of the dissociation energy is the subject of controversy), then this reaction would be sufficiently exothermic. It may be noted that all flames which show the high rotational temperature for hydroxyl also emit CH bands strongly.

Some progress has been made with measuring effective translational temperatures, thanks to a suggestion by Sir Alfred Egerton; this is by measuring the Doppler broadening of the spectrum lines. A Fabry–Perot interferometer is crossed with a large-dispersion spectrograph. Measurements are only reliable at low pressure because of pressure-broadening effects at high pressure. Also, self-absorption may cause trouble. For lines of lead and iron and perhaps for hydroxyl, the effective translational temperature appears to agree with the expected flame temperature. For lines of the CH bands, however, the effective translational temperature at low pressure is high, about 4,000° K.

Less progress has been made with vibrational temperatures, although some anomalies in vibrational intensity distribution have been noted. In oxy-hydrogen flames at low pressure, there appears to be selective excitation of hydroxyl to the $v' = 2$ level, that is, to a level with vibrational quantum number 2. This requires an energy of 108 kcal. per mole. The most likely reaction is

$$H + H + OH = H_2 + OH^*.$$

The reaction gives only 103 kcal., but the remainder may be accounted for as, perhaps, activation energy. A similar intensity anomaly has recently been observed in the CH bands, when organic compounds are added to the flame, by Mr. R. A. Durie, who has recently started work in my laboratory. These results support other indications that there is an excess of atomic hydrogen in hydrogen flames.

Effective electronic excitation temperatures may be determined by the spectrum line reversal method. Results are often very anomalous for pre-mixed flames of hydrocarbons. Thus, when lead is introduced into an oxy-acetylene flame at low pressure, the resonance line of lead at 2833 A. is reversed against the background of a carbon arc; it has a reversal temperature of about 3,300° K., about 600° above the flame temperature. The other lines, 2802 A., 2823 A., etc., however, show in emission against the carbon arc, and have brightness temperatures in excess of 4,500°. Some lead lines observed in emission require 150 kcal. per mole of excitation energy.

A recent important development is that of the design of a flat diffusion flame for spectroscopic study[1]. This type of flame is suitable for absorption spectra as well as for the study of emission. It may be stressed at this point that emission from diffusion flames appears to be mainly thermal in origin, in contrast with the emission from the inner cones of pre-mixed flames which show abnormally high excitation.

Another approach to the subject resembles that of chemical kinetics. The yield of light for various band systems may be studied in various flames and with various diluents, and some rather surprising results are being obtained. Thus, if in a flame of ethane and oxygen the ethane is progressively replaced with hydrogen in such a way as to keep the mixture stoichiometric, the flame temperature does not vary appreciably, and we might expect, on a naïve approach, that the strength of the $C_2$ bands would fall off proportionally with the ethane concentration. Actually, it falls off much more rapidly, approximately as the cube of the ethane concentration. Present indications are that the formation of $C_2$ and CH in pre-mixed flames requires polymerization of the fuel.

So far, the spectra considered have all been band systems, indicating the presence of certain molecules in the flames. Flame spectra also contain a good deal of continuous emission. This continuum may arise from various causes, but it always indicates a process taking place rather than the mere presence of something. Processes of association and dissociation of molecules and of the formation and recombination of ions are responsible for the emission of continuous spectra. These are usually difficult to identify because of the characteristic lack of marked features. In the carbon monoxide flame the strong blue radiation has a mainly continuous spectrum, which is probably due to recombination of carbon monoxide and atomic oxygen.

The afterglow of air in a discharge tube is due to recombination of atomic oxygen with nitric oxide to form nitrogen dioxide. This yellow-green afterglow resembles the colour of the tip of some very hot flames; and I have identified this emission from flames with the $NO + O = NO_2$ reaction, and developed a test for the presence of atomic oxygen in a flame. On introduction of nitric oxide, some flames turn yellow-green. If, however, a hydrocarbon flame, such as an ethylene–air flame, is separated into its two cones in a Smithell's flame-separator, and nitric oxide is added to the fuel stream, then a marked yellow-green coloration may be seen in the outer cone, where carbon monoxide and hydrogen are burning, but not in the inner cone, where the initial break-up of the hydrocarbon occurs. From a detailed consideration of this, it can be shown that there is very little atomic oxygen present during the early stages of reaction, and this is evidence against combustion mechanisms requiring atomic oxygen.

While considerable advances have been made in the study of flame spectra during the past few years, we are still ignorant on many fundamental points. We do not know with certainty how $C_2$ and CH are formed, or the cause of the abnormal excitation in pre-mixed hydrocarbon flames. Quantitative

measurements of the yield of light under various conditions, and detailed spectroscopic studies such as those of the astrophysical type, may be expected to give further information in the not very distant future.

[1] Wolfhard, H. G., and Parker, W. G., *Proc. Phys. Soc.*, A. **62**, 722 (1949).

## ENERGY EXCHANGE BETWEEN THE OCEANS AND THE ATMOSPHERE

PROGRESS in oceanographical research and its applications to marine physical and biological problems is likely to be slow until more is known about the natural processes which regulate the water movements in the oceans and the distribution of physical properties. Interaction between the atmosphere and the oceans is the most important of these processes, and particular attention is being paid to it in marine physical laboratories; the same information has useful applications to meteorology, and studies are being made of the vertical profiles of wind velocity, temperature and vapour pressure, close to the sea surface, and of the changes in heat and moisture content of air masses moving over the oceans. Recent progress formed the basis of a Geophysical Discussion held at the Royal Astronomical Society on October 28, at which Prof. P. A. Sheppard, of the Department of Meteorology, Imperial College of Science and Technology, and Mr. K. F. Bowden, of the Department of Oceanography, University of Liverpool, were the principal speakers.

The oceans gain most of their heat directly from the radiation of the sun, and it is estimated that they absorb nearly half the amount which reaches the outer limit of the atmosphere above them. The amounts received in different regions depend mainly on the latitude, time of year and the cloudiness of the sky. Since there is no appreciable change in the total heat content of the oceans, the gains must be balanced by losses, and it is known that heat is lost mainly by evaporation, by radiation to space, and to a lesser degree by conduction of heat from the water to the air. Regional heat balances are influenced to a considerable extent by the transfer of heat from one area to another by ocean currents.

The lower atmosphere gains most of its heat from the oceans; it is very transparent to direct radiation from the sun, and the difference between the amount of radiation reaching the upper limit of the atmosphere and that absorbed in the ocean is accounted for mainly by reflexion back to space from the atmosphere, clouds and water surface. The possible effect of absorption of short wave-length radiation in the very highest atmosphere is not known. Most of the heat is received from the condensation of water vapour, supplemented by direct conduction from the water. As in the oceans, there is no appreciable change in the total heat content from year to year, and the gains must be balanced by losses—chiefly by radiation to space. Numerical values have been given by various authors for the amounts of incoming and outgoing radiation in different latitudes and seasons, and also for the effect of reflexion from the sea, evaporation and conduction. They are all subject to revision; but they are sufficiently accurate to lead to reasonable conclusions when applied to the oceans as a whole, and to areas in which the changes from month to month in the heat content of the water are known.

Such information is not often available, and the transfer of heat from the sea to the air in a particular region is usually estimated from information about the vertical gradients of temperature and vapour pressure near the surface, and about the turbulent processes by which they diffuse upwards into the atmosphere. Complete data are never available, but by using a formula developed by H. U. Sverdrup[1] for evaporation at moderate and high wind-speeds, the routine observations, made by ships, of wind strength, sea temperature, and wet- and dry-bulb thermometer readings can be employed as a basis for the calculations. The amount of heat transferred by conduction can be calculated from the same figures, if it is assumed that the diffusion processes for temperature and water vapour are similar. W. C. Jacobs[2] has prepared maps of the heat losses from all parts of the North Atlantic and North Pacific Oceans for which long-period climatic data are available. The main features of the maps are areas of maximum heat-transfer where the Gulf Stream and Kuro Siwo current carry warm water northwards off the east coasts of the United States and Japan, the amount being much greater in winter than in summer. Both areas are regions in which violent storms originate.

Mr. K. F. Bowden[3] gave a brief description of his study (1948) of the heat transfer from the Irish Sea. Using assessments of incoming and outgoing radiation and measurements of the heat content of the water from month to month, he showed that the transfer of heat to the atmosphere is greatest in autumn and least in summer. He found some discrepancy between the heat transfer estimated by this method and that calculated from monthly figures for wind strength, sea and air temperatures, and relative humidity. In the discussion that followed, Prof. M. Neiburger (University of California) mentioned recent observations which suggest that there must be some revision of previous estimates of the effect of cloud. Mr. Bowden mentioned that there is some uncertainty about the formula for evaporation: some workers hold that the amount is practically independent of the state of the surface, while others suggest that it is four times as great for a rough as for a smooth surface. Other speakers remarked that discrepancies could result from the difficulty of making observations sufficiently close to the surface. Attention was directed to evidence that in calm and moderate weather there can be a thin film of water at the surface in which the temperature differs significantly from that measured by dipping a bucket. Mr. J. Francis argued that greater use should be made of laboratory models.

Several speakers emphasized the need for further study of the diffusion processes near the sea surface with simultaneous observations in air and water, the behaviour of one being inexplicable without due regard to the other. Some disappointment was expressed that the state of knowledge and time available did not allow more to be said about the transfer of kinetic energy from the atmosphere to the sea; it was felt that there is a danger of underestimating the proportion of the heat content of the atmosphere which is turned into mechanical energy, and of the fraction of this mechanical energy which is transferred to the oceans to contribute to the growth of waves, temporary wind drifts and permanent ocean currents. With reference to such transfer, Mr. H. Charnock showed that if data from every

available source are plotted, the break between 'smooth' and 'rough' surfaces described by W. H. Munk[4] is not proved, though some of the other evidence, such as the abrupt change in the flight of seagulls at wind speeds of about 7 metres a second (15½ m.p.h.), is more convincing. Mr. L. Verra, referring to preliminary results of measurements made to determine the tangential wind stress from the changes in slope of the surface of Lough Neagh, said that, although the observations show considerable scatter, they are in general agreement with the assumption that the stress is proportional to the square of the wind velocity for all wind strengths up to 20 knots. Using this assumption, the mean stress coefficient is 0·0013, which is approximately the mean of all the other values that are available. If the observations are grouped according to air temperatures, there is evidence that the stress is greater when the air is unstable.

Prof. P. A. Sheppard gave some indication of how the calculation of heat transfer from the sea would be useful in meteorology and climatology. Mr. J. Craddock, of the Forecasting Research Division, Meteorological Office, quoted a heat transport of 600 cal./cm.²/day from sea to air measured by observations at twenty-five points in the path of a particular air mass. This was understood to be in agreement with Jacobs's[3] calculations for the North Atlantic Ocean in winter. Interaction with the oceans is only part of the meteorological problem; but the ocean surfaces are four times as extensive as the land, and some of the processes which require investigation may be simpler owing to the absence of topographical effects. The heat transfer is only part of the oceanographical problem, since the permanent ocean currents seem to derive most of their energy from the mechanical stress of the wind on the sea surface. Such a current may play an important part in determining the amount of energy which is available for transfer to the atmosphere in a particular region, and every change in the prevailing wind will lead to a change in the current which must again affect the atmosphere. The details of the interaction between the oceans and atmosphere have still to be worked out, and there is no doubt that their investigation offers great scope.

G. E. R. Deacon

[1] Sverdrup, H. U., *J. Marine Research*, **1**, 3 (1937).
[2] Jacobs, W. C., *J. Marine Research*, **5**, 37 (1942).
[3] Bowden, K. F., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, **5**, 270 (1948).
[4] Munk, W. H., *J. Marine Research*, **6**, 203 (1947).

## OPENING OF THE NATIONAL CHEMICAL LABORATORY OF INDIA

THE Council of Scientific and Industrial Research of India planned eleven national laboratories. The seventh of these, the National Chemical Laboratory, is nearing completion and was officially opened by the Prime Minister of India, Pandit Nehru, on January 3. A description of the preliminary plans was given in *Nature* of February 15, 1947.

Begun in April 1947, the building, of Western design and magnificent proportions, makes an impressive picture set in a natural amphitheatre of hills about four miles from Poona. It is well equipped for scientific research in chemistry in both pure and applied fields, and when completely staffed will operate through nine departments; namely, organic chemistry, biochemistry, chemical engineering, plastics and high polymers, survey and information, inorganic chemistry, physical chemistry, administration and standardization of chemicals, development of bhilawan and cashew products. It will thus provide the possibility of effective co-operation between scientific research and industrial production—a co-operation which is essential to sound economy.

The important problem of collecting the right personnel for staffing is gradually being solved by the director, Prof. J. W. McBain, whose unceasing labour since his arrival in October 1949 is largely responsible for the advanced stage which the Laboratory has already reached. Several of the nine departments are already operating, and about seventy-six of the staff, which will ultimately number some one hundred and fifty scientific men, are appointed.

In his opening speech, Pandit Nehru stressed the importance of "personnel, which provides the essential spirit of an institution. It is more important than the buildings themselves, necessary and splendid though they are". He pointed out that "India has the people and the talent. The problem is to tap that talent. Money itself cannot be produced without people, and a country which is rich in talented people must therefore possess a potential source of wealth. People can make money, but money cannot make people. But it is not sufficient to make money alone, it is also necessary to concentrate on scientific advancement." He was surprised at the amazing ignorance of the importance of science to industry among industrial leaders. On the other hand, it might be said with justification that the Government had, during the past two years, done something in the matter of science and scientific research—it had at least laid the foundations of future work.

After the opening, Prof. McBain, addressing the large and distinguished audience, dedicated himself and the whole of the personnel to the service of the people of India and invited their co-operation, stressing its importance. He went on to speak of the ethical and spiritual qualities necessary for the pursuit of science. Science is in no way at variance with the highest spiritual and ethical aims, but must of necessity be integrated with them. Thus, devotion to truth, no matter how unwelcome or what personal self-sacrifice it involves, is, above all else, essential. Loyalty is also a requisite—loyalty both to the work undertaken and to humanity as a whole. Only those whose characters include such attributes are in a position to render any worthwhile service; but such true service, however small, is eternal in the mind of God.

The proceedings were presided over by His Excellency the Governor of Bombay. Others who took part were the Honourable Dr. Syama Prasad Mookerjee, Minister of Industry and Supply, and vice-president of the Council of Scientific and Industrial Research; Sir Shanti Bhatnagar, director of scientific and industrial research; and four Nobel laureates, Sir Robert Robinson, Dr. A. H. Compton, Madame Joliot-Curie and Sir C. V. Raman.

After the opening, the Laboratory was inspected by Pandit Nehru, attended by the Director; and a large number of scientific workers, including many from overseas, toured the building and saw the numerous exhibits set up in the various laboratories already operating. About five thousand people attended the colourful ceremony.

# OBITUARIES

## Dr. Isaiah Bowman

THE sudden death of Dr. Isaiah Bowman at Baltimore on January 6, eleven days after his seventy-first birthday, has robbed the world of its premier geographer and the United States in particular of an elder statesman in the true sense of the word, whose wise counsels had for forty years been at the disposal of successive Presidents.

By birth a Canadian, his childhood and schooldays were spent in Ontario, and it was to secure better training as a teacher that he went to Ypsilanti in Michigan in the United States, which was henceforth to be his adopted country. From Ypsilanti he went on to take a degree in science at Harvard, and after one year back at Ypsilanti he returned to Harvard as assistant professor of physiography. The following year, 1905, when he was twenty-six, he joined the Department of Geography at Yale, where he remained for ten years. His work there serves as a model for all young geographers. He combined a thorough study of his own continental area with pioneer exploration in South America. He was a leader in 1907 of an expedition to the Andes of South America promoted by Yale University, and in later years took part in many other exploratory journeys in that continent. As a result of his home studies, there appeared in 1911 the volume entitled "Forest Physiography". The contents of this book to some extent belie its title. It is, in fact, a very thorough study of the physiographical conditions in the United States as they influence the natural vegetation cover, and so provide the essential environments for human settlement. His journeys in South America resulted in a series of scholarly monographs, culminating in his book, "The Desert Trails of Atacama", issued as a special publication by the American Geographical Society in 1924.

In the meantime, after leading the American Geographical Society's expedition to the Central Andes in 1913, he had been appointed director of the American Geographical Society in New York, a post which he held for twenty years, from 1915 until 1935.

During the First World War, the American Government found in Dr. Bowman the ideal man to collect vital geographical information on an immense range of topics, and it was natural that he should play a major part in the Versailles Peace Conference. Few universities in Britain, or indeed in many other countries in the world, had at that time either undergraduate or advanced courses in geography. This fact was reflected in the inadequate factual knowledge at the disposal of many of the delegations to the Conference. In contrast, the American delegation showed itself amazingly conversant with the intricacies of European political geography. It is enormously to Dr. Bowman's further credit that he quickly gave to the world after the Peace Conference his book "The New World", which has run through many editions and which described with utmost lucidity the political geography so largely determined by the post-war settlement.

From that time onwards, Dr. Bowman remained in closest touch with successive Presidents of the United States. With his guidance, the American Geographical Society became the focus of much important research; under its auspices came the stream of 1:1,000,000 maps of South America. Dr. Bowman himself turned his attention to the problems of the development of marginal lands. His book in this field, "The Pioneer Fringe", is one which we should all do well to study at the present day, in that it shows the difficulties met by pioneers both in the past and at present, and how frequently adverse natural conditions have succeeded in driving back the over-bold, a fact which is being forgotten by those who talk at present too eagerly of the development of tropical lands.

In 1935, Dr. Bowman became president of Johns Hopkins University, from which he retired only shortly before his death on reaching the age of seventy. Again his clarity of vision saw a way of overcoming one of the major difficulties before the universities of to-day, where the professor or head of the department is so often swamped by routine duties resulting from immense numbers of students. He established at Johns Hopkins University a Department of Geography under the chairmanship of a young, energetic geographer, leaving such senior teachers as Owen Latimore and R. L. Pendleton free to pursue their own researches. The School was designed for a relatively small number of carefully selected students; but the principle of appointing a relatively young head of department to shoulder administrative responsibility is one that has since been copied with advantage elsewhere.

During the Second World War, Dr. Bowman's immense range of knowledge was once more in constant demand. On several occasions he had such delicate missions as conveying personal messages from President Roosevelt to Mr. Churchill, and it is not too much to say that he was an important architect of both the League of Nations and the United Nations Organisation.

Honours from many universities and learned societies included an honorary degree from Yale in 1921, the Livingstone Medal of the Royal Scottish Geographical Society in 1928, the Patron's Medal of the Royal Geographical Society in 1941, and an honorary D.C.L. of the University of Oxford in 1944.

Dr. Bowman was a man of great personal charm. To many of the young geographers, like the present writer, he was not only a readily accessible counsellor, but also a very real friend. He had a flair for almost instantaneous appreciation of good or promising work. He was very practical in his outlook. He found philosophical discussion on the delimitations of fields of study arid and irksome; but he was immensely alive to the possibilities of the application of geographical methods to world problems, as shown by his "Geography in Relation to the Social Sciences" (1934). Only three weeks before his death, when the Commission appointed by the International Geographical Union had drawn up at Worcester, Mass., its scheme for a Land Use Survey of the World, the main proposals were read over the telephone to Dr. Bowman at his home, and in the course of half an hour's conversation he not only gave his blessing to the scheme and his promise to further the objective, but also made many valuable comments on detail. The loss of such a vigorous mind and a great world figure is a world tragedy. L. DUDLEY STAMP

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WE regret to announce the death of Prof. Richard Fosse, a former occupant of the chair of chemistry applied to organisms in the Natural History Museum, Paris, and member of the Section of Rural Economy and Veterinary Practice of the Paris Academy of Sciences, on December 18, 1949, aged seventy-nine.

# NEWS and VIEWS

## Anthropology at Cambridge : Prof. J. H. Hutton, C.I.E.

PROF. J. H. HUTTON is to retire this year from the William Wyse chair of social anthropology at Cambridge which he has held since 1937. Prof. Hutton entered the Indian Civil Service in 1909. Posted first to Eastern Bengal, he was transferred to Assam in 1912 and served for the next seventeen years in the Naga Hills. Up to that time little or no anthropological work had been done on the tribes in the Naga Hills district, and Hutton soon set himself to remedy this deficiency, first in the interests of administration and later in those of science. The First World War kept him in the Naga Hills but prevented the publication of any considerable work until 1922, when he published both the "Angami Nagas", which had been finished much earlier, and the "Sema Nagas". Meanwhile, in addition to his administrative duties as deputy commissioner of the Naga Hills, he had been appointed honorary director of ethnography for Assam, and in virtue of that office promoted the publication of a number of other tribal monographs by his colleagues, on the Naga and Kuki-Lushei tribes. For his work as political officer in the Kuki Punitive Operation of 1917–19 he was awarded the C.I.E. He left Assam in 1929 to undertake responsibility for the India Census of 1931, and for four years Delhi and Simla were his headquarters. This task enabled him to become acquainted with many of the remoter parts of the Indian Empire. In addition to the two volumes already mentioned and his "Report on the Census of India, 1931", he published grammars of the Sema and Chang-Naga languages, previously not reduced to writing, and two or three readers for elementary schools in those vernaculars. His "Caste in India" was published in Cambridge in 1948. His honours have included the Rivers Memorial Medal of the Royal Anthropological Institute in 1929, the Silver Medal of the Royal Society of Arts in 1932, and the Annandale Memorial Gold Medal of the Asiatic Society of Bengal in 1937. He was Frazer Lecturer in Oxford in 1938. Prof. Hutton has done much to consolidate the Cambridge school of archæology and anthropology, where he has admirably held the balance between the various subjects taught, and has proved an excellent chairman of the Faculty Board. During the War, he carried most of the burden of the anthropological teaching on his own shoulders.

## Dr. M. Fortes

DR. MEYER FORTES, who will succeed Prof. Hutton, was born in 1906, educated at the South African College High School and the University of Cape Town, and is a Ph.D. of London, where his post-graduate degree was taken in psychology under the late Prof. C. Spearman in 1930. Working as a research assistant to the late Prof. Seligman, he turned from psychology to anthropology in 1932 and continued to study under Malinowski as a Rockefeller fellow. During 1934–37 he worked in the Northern Territories of the Gold Coast, and on return from the field was appointed lecturer in social anthropology at the London School of Economics in 1938. The following year he was appointed research lecturer in African sociology at Oxford. In 1941 he undertook a field survey of Nigeria on behalf of the Nuffield Colonial Research Scheme, and after this was engaged on national service until appointed head of the Sociological Department of the West African Institute, Gold Coast, and director of the Ashanti Social Survey, in 1945. In 1946 he was appointed reader in social anthropology at Oxford. He holds the Wellcome Gold Medal of the Royal Anthropological Institute (1937) and its Rivers Memorial Medal (1947). His two most important published works are "The Dynamics of Clanship among the Tallensi" (1945) and "The Web of Kinship among the Tallensi" (1949); and he is the editor of the *Journal of the Royal Anthropological Institute*.

## Higher Technical Education in the Colonies

MR. ARTHUR CREECH JONES, Secretary of State for the Colonies, has set up a committee to advise him on the development of Colonial colleges of arts, science and technology (hitherto referred to provisionally as 'regional colleges'). The committee's provisional terms of reference are as follows: "To advise the Secretary of State and any responsible authorities in the Colonies on the development of Colonial Colleges of Arts, Science and Technology and to advise on expenditure of Colonial Development and Welfare funds allocated for this purpose". The committee is as follows: Dr. Keith A. H. Murray (chairman), rector of Lincoln College, Oxford; Mr. T. H. Baldwin, formerly deputy director of education, Nigeria, now assistant educational adviser to the Secretary of State for the Colonies; Mr. H. T. Bourdillon, head of Finance Department, Colonial Office; Sir Christopher Cox, educational adviser to the Secretary of State; Sir James Duff, pro-vice-chancellor, University of Durham; Sir William Hamilton Fyfe, formerly vice-chancellor and principal, University of Aberdeen; Dr. F. J. Harlow, formerly principal, Chelsea Polytechnic; Mr. R. J. Harvey, formerly director of education, Zanzibar, now in the Colonial Office; Mr. J. C. Jones, principal, Regent Street Polytechnic; Prof. Margaret Read, professor of education with special reference to education in the Colonies, and head of the Colonial Department, University of London Institute of Education; Mr. J. J. Robertson, rector, Aberdeen Grammar School; Dr. J. E. Richardson, principal, Northampton Polytechnic, London; Mr. H. C. Shearman, academic adviser for tutorial classes, University of London, vice-president and formerly education officer, Workers' Educational Association; Dr. Cameron Smail, principal, Heriot-Watt College, Edinburgh; Rev. R. W. Stopford, secretary of council and moderator of Church Training Colleges, formerly principal of Achimota College, Gold Coast; Mr. W. Adams (observer), secretary to the Inter-University Council for Higher Education in the Colonies, and Mr. H. M. Collins, Colonial Office (secretary).

Initially, the committee will be concerned primarily with West Africa. It is hoped that two new colleges will be established in the immediate future: one serving the Gold Coast, at Kumasi, and the other, in Nigeria, is likely to be a tripartite organisation with branches in each of the territory's three regions. These colleges will be complementary to the existing university colleges. It will be their aim to provide courses of higher technical and commercial education of whatever type may seem best suited to the needs of each territory; also courses for the training of teachers and social welfare and community development workers. In addition, they will participate in schemes of adult education, and, pending further developments in secondary education, will provide general

education at higher certificate level. They will become centres for cultural and technological development, for refresher courses, and for the encouragement of the arts and crafts. Generally, they are designed to be readily adaptable to meet the varying needs of the territories they serve. Although the reconstituted Fourah Bay College in Sierra Leone will differ in many respects from the new colleges in Nigeria and the Gold Coast, more particularly in that it will retain and develop its University Department, the committee will be ready to advise and assist it. In addition to offering advice on general development and the allocation of United Kingdom funds available for these Colleges under the terms of the Colonial Development and Welfare Act, 1945, the committee will also be responsible for advising on the selection of staff.

## Festival of Britain, 1951

In connexion with the Festival of Britain, to be held during May–September 1951, it has been recently announced that the display of British achievements in science and technology will be centred on four projects: South Bank Exhibition, London; Travelling Exhibitions; 1951 Exhibition of Science, Science Museum, South Kensington, London; 1951 Exhibition of Industrial Power, Kelvin Hall, Glasgow. Details of the South Bank Exhibition have already been given (see *Nature*, December 24, 1949, p. 1083), and the two Travelling Exhibitions, which will be on the lines of that on the South Bank, will tour Great Britain by land and by sea; the latter will be fitted up in the escort carrier *Campania*. The theme for the South Kensington Exhibition is limited to the growth of the understanding of the nature and architecture of matter. The sequence will proceed from the study of matter (physical, chemical and biological) on a macroscopic scale down through the orders of magnitude to atomic and nuclear particles. This Exhibition is designed primarily for those who, though not necessarily trained in any specific science, have a general leaning towards things of scientific interest. Engineering machinery and the part it has played in shaping the British citizen's daily life will be shown at the Glasgow Exhibition, where the two principal topics will be coal and water. The former will cover mining, iron and steel, machine tools, power units, electric power generation and transmission, railways and shipbuilding; the latter will consider hydro-electricity, civil engineering and irrigation. The two themes will be integrated in the final section, which is on the future use of nuclear energy for industrial power.

## Systemic Insecticides and Swollen Shoot Disease of Cacao

The director of the West African Cacao Research Institute, Tafo, Gold Coast, has arranged for a team of three men of science from Messrs. Pest Control, Ltd., Bourn, Cambridge, to work at the Institute on an investigation of the possible use of systemic insecticides to control the spread of swollen shoot disease of cacao in West Africa. The object of these experiments is, of course, not to kill the virus of swollen shoot disease but to kill the mealybug which is the vector of the disease. Thus, the most that the discovery of an effective systemic insecticide could achieve would be to prevent or reduce the spread of infection from trees infected with swollen shoot to healthy trees, and three or four years at least must elapse before any conclusion, positive or negative, can be reached. There is no known cure for a plant disease virus once it is established in a tree or plant, and the only way to kill the virus is to destroy the tree or plant itself. Cutting-out of diseased trees must, therefore, always remain an essential and fundamental part of any successful campaign to rid the cocoa-growing areas of West Africa of the scourge of swollen shoot disease (see *Nature*, **163**, 15 and 271; 1949).

## *Physics Today*: Costs of Production

It is announced in the editorial of the October issue of *Physics Today* that, beginning in January 1950, the free distribution of that monthly periodical to members of the American Institute of Physics will cease. The annual subscription will be 4 dollars for members of the Institute and 5 dollars for non-members. It had been hoped that *Physics Today*, which has appeared regularly for some twenty months (see *Nature*, **162**, 988; 1948), would by 1951 be self-supporting; but it is now clear that, because of the increase in the number of members of the Institute, the rise in the cost of printing and the rather slow increase in the number of advertisers and subscribers, this cannot be achieved. It will be remembered that *Physics Today* is a general-interest journal on physics, a non-technical magazine limited to one science, but "in which physics and the things about it are put in a language which others can use for better understanding". There is a definite need for a medium through which news and discussion of what is going on in physics can be made known to physicists in general, to men of science working in other fields than physics and to the general public. *Physics Today* has so far admirably fulfilled this need, and it is to be hoped that it will continue to receive adequate support in spite of the increased cost to subscribers.

## Infra-red Discussion Group

A meeting of people engaged on, or interested in, infra-red spectroscopy was held in the Royal Technical College, Glasgow, on January 20, in order to consider the formation of a discussion group on mutual problems and interests. It was decided to form an informal body to be called the Infra-red Discussion Group. Dr. A. E. Martin (Sir Howard Grubb, Parsons and Co.) was elected chairman, and Mr. K. S. Tetlow (Imperial Chemical Industries, Ltd., Nobel Division, Stevenston, Ayrshire) secretary. Membership (no fee) is open to persons, firms and organisations willing to co-operate, when possible, in the activities of the Group. The first meeting considered comparative extinction coefficient measurements, the reporting of spectra, definitions and instrumental matters.

## Frank Knox Memorial Foundation Fellowship

A fellowship, worth 2,400 dollars, of the Frank Knox Memorial Foundation is being offered for a male student from the United Kingdom to spend the academic year 1950–51 at Harvard University. The fellowship is open to students of all stages, preference being given to graduates or those about to graduate, and a major part of the year must be spent studying in one of the faculties at Harvard. Applications (by letter on quarto paper, five copies) should include full particulars of past career and prospective course of study, together with a testimonial of the candi-

date's supervisor and the name of a referee. Such applications should be forwarded, not later than April 1, through the head of the applicant's university or college to the Secretary, Association of the Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1, from whom further particulars can be obtained.

## Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have been recently announced: L. J. Foster, agricultural officer (horticulture), Nyasaland; N. Lamont, agricultural officer, Fiji; T. O. Robson, pasture research officer, Tanganyika (seconded to Kenya); R. J. Spooner, agricultural officer, Kenya; S. K. Reakes-Williams, agricultural officer, Tanganyika; W. J. Harrison, J. S. Lightbody and H. Searle, assistant conservators of forests, Nigeria; J. A. Goodlet, assistant conservator of forests, Trinidad; J. G. Lumsden, assistant conservator of forests, Northern Rhodesia; J. D. Todd, assistant conservator of forests, Mauritius; D. C. Jones, geologist, Nigeria; E. R. Pollard, geologist, British Guiana; D. F. Hamilton and J. G. Ross, veterinary officers, Cyprus; J. D. Rennie, veterinary officer, Nyasaland; M. M. Scott, veterinary officer, Northern Rhodesia; D. G. Bouring, agricultural cocoa survey officer, Gold Coast; D. P. Braithwaite, biochemist, Veterinary Department, Kenya; C. A. Ellis and J. Longden, assistant statisticians, Nigeria; R. S. Hall, statistician, East Africa High Commission; P. A. Towsey, statistician, East Africa Statistical Department, East Africa High Commission; D. R. Niven, fisheries officer, Federation of Malaya; A. McDonald, meteorologist, Federation of Malaya; W. H. Whitely, anthropologist, Tanganyika; C. E. J. Biggs (deputy director of agriculture, Tanganyika), director of agriculture, Tanganyika; G. B. Gregory (agricultural superintendent, Grenada), senior agricultural officer, British Honduras; G. W. Lines (principal agricultural officer, Sierra Leone), deputy director of agriculture, Sierra Leone; H. MacLuskie (senior agricultural officer, Sierra Leone), station agricultural officer, Rice Research Station, Sierra Leone; B. J. Silk (agricultural officer, Gold Coast), agricultural education officer, Gold Coast; J. R. P. Soper (senior agricultural officer, Federation of Malaya), deputy director of agriculture, Tanganyika; S. G. Wilson (senior veterinary research officer, Uganda), chief field zoologist, Kenya; Miss F. M. L. Sheffield (specialist officer, Clove Research Scheme, Zanzibar), cytologist, East African Agriculture and Forestry Research Organisation; N. Yenli (assistant agricultural officer, Gold Coast), agricultural education officer, Gold Coast.

## Exhibition in London of French Scientific Instruments

IN connexion with this Exhibition at the Science Museum, London, S.W.7 (see *Nature*, January 14, p. 59), the following lectures have been announced: February 8, at 4.15 p.m., Prof. E. Bauer, on "Scientific Research in France"; and H. Volkringer, on "The Centre National de la Recherche Scientifique, and the Commission des Inventions" (admission by tickets obtainable from the Scientific Office, French Embassy, 58 Knightsbridge, London, S.W.1). February 9, at 6 p.m. (at the French Institute, Queensberry Place, London, S.W.7), Prof. E. Bauer, on "Philosophie de la mesure et de l'observation en physique". February 10, at 4.30 p.m., Dr. J. Guéron, on "Some Methods and Instruments used at the Commissariat à l'Energie Atomique", and L. Couffignal, on "The Calculating Machine of the Institut Blaise Pascal". February 14, at 4.30 p.m., P. Le Rolland, on "Pendulum Methods for the Study of the Elastic Properties of Solids". February 16, at 4.30 p.m., P. de Fonbrune, on "Some New Methods of Micro-manipulation". February 21, at 4.30 p.m., M. Chevenard, on "Some French Apparatus for Use in Metallographic Research" (lecture to be read by Dr. L. Haughton); and Ingénieur Général C. R. Libessart, on "The Kinetics of Carbon Reactions". February 24, at 4.30 p.m., Dr. L. Kowarski, on "Atomic Energy Developments in France: 1946–1950". Except where stated, the lectures will be given in the Lecture Theatre of the Science Museum, and with the exception of those on February 8, are open to the public without tickets.

## Announcements

PROF. J. B. ELIAS MELIN, professor in the Institute of Physiological Botany, University of Uppsala, has been elected *Correspondant* for the Section of Botany of the Paris Academy of Sciences in succession to the late M. Emmanuel Teodoresco.

THE Liverpool University Chemical Society Medal for 1950 has been awarded to Dr. W. H. Garrett, a graduate of the University and a director of Monsanto Chemicals, Ltd., for services to chemistry in the industrial field. The Medal will be presented at the annual open meeting of the Society on February 23 at 4.30 p.m., when Dr. Garrett will deliver a lecture entitled "The Need for Flexibility in University–Industry Relations".

THE Council of the Institute of Fuel announces that Mr. J. F. Ronca, at present honorary secretary of the Institute, will succeed Dr. D. T. A. Townend as president in October 1950. The Melchett Medal for 1950 has been awarded to Prof. R. J. Sarjant, professor of fuel technology in the University of Sheffield.

DR. J. PEARSON, head of the Chemistry Section of the British Iron and Steel Research Association Laboratories at Sketty Hall, Swansea, since 1946, has been appointed head of the Chemistry Department of the Association in succession to Dr. F. D. Richardson. Dr. Pearson is a graduate of the University of London, and was awarded the degree of Ph.D. in 1946 for research on the polarography of nitro-compounds. In his new post, he will be responsible for research on the physical chemistry of iron and steel making, refractories and problems of corrosion.

A David Anderson-Berry Silver-Gilt Medal, with a sum of about £100, will be awarded during 1950 by the Royal Society of Edinburgh for work on the therapeutical effect of X-rays on human diseases. Applications (with copies of relevant papers on accomplished work) must be sent to the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, by March 31, 1950.

ERRATUM. Dr. W. Boas and Mr. P. J. Fensham state that in their communication entitled "Rate of Self-Diffusion in Tin Crystals" in *Nature* of December 31, 1949, p. 1127, they have discovered an arithmetical error in the computation of the constant $A$ parallel to the $c$-axis, which appeared in Table 2 as $8{\cdot}4 \pm 3 \times 10^{-4}$. This should read $1{\cdot}2 \pm 0{\cdot}45 \times 10^{-4}$. The ratio $A_c/A_a$ should therefore be $\sim 10^3$, not $\sim 10^4$ as stated. This alteration, however, leaves the conclusions quite unaffected.

# CARBON DIOXIDE AND THE EXTENSION GROWTH OF ETIOLATED OAT SEEDLINGS

By C. L. MER and F. J. RICHARDS

Research Institute of Plant Physiology, Imperial College of Science and Technology, London, S.W.7

THE possibility of carbon dioxide entering metabolic cycles in higher plants in the absence of light may no longer be disregarded in view of the discovery of its assimilation by bacteria[1] and of recent work on the first stage of photosynthesis[2,3]. Heath[4] has further demonstrated that change in carbon dioxide concentration below that normally found in air is an active factor controlling stomatal movement.

In the course of an investigation on the effects of illuminating etiolated oat (*Avena*) seedlings, a further effect has been noted, namely, stimulation of extension growth of the mesocotyl, and depression of growth of the coleoptile.

The plants were grown under litre beakers lined with damp blotting paper to maintain a humid atmosphere, in cylindrical tin containers some 6 in. in diameter and 7 in. tall, provided with closely fitting lids to exclude light. It was found that the mesocotyls of such seedlings when seven days old varied considerably among the replicate tins; in some cases the average length was approximately 70 mm., while in others it was more than 80 mm., and this difference was significant at the 1 per cent level. Columns 1 and 2 in Table 1 show the measurements in mm. obtained on two successive occasions with containers *A* and *B* selected to show the differences.

There was no disparity in the size of the tins, and in view of the known effect of light in reducing the length of the mesocotyl, both were tested for light leaks by placing photographic paper in them. The paper was found to remain unaffected. The only difference observed was that the lid of *B* fitted tightly while that of the other was looser, and the possibility emerged that differences in gaseous exchange due to this cause may have been responsible for the variability noted.

The first test, therefore, was to bind the junction of the lid and body in both cases with gummed paper tape; the measurements of the plants after a seven-day growing period under these conditions are shown in column 3. The mesocotyls were now comparable in length, owing to *increased* growth within tin *A*.

A quantity of 10 *M* potassium hydroxide was next included in container *B* (which formerly produced the longer mesocotyls), the other acting as control; the lid junction in both cases was sealed with 'Plasticine', which was more satisfactory than the gummed paper previously used. The plants were again measured when seven days old; the lengths are recorded in column 4, and it will be seen that the absence of potassium hydroxide resulted in a marked increase in the length of the mesocotyl. To ensure that this was not fortuitous, potassium hydroxide was later included in container *A*, *B* acting as control. The results (column 5) show the same effect but in the other tin.

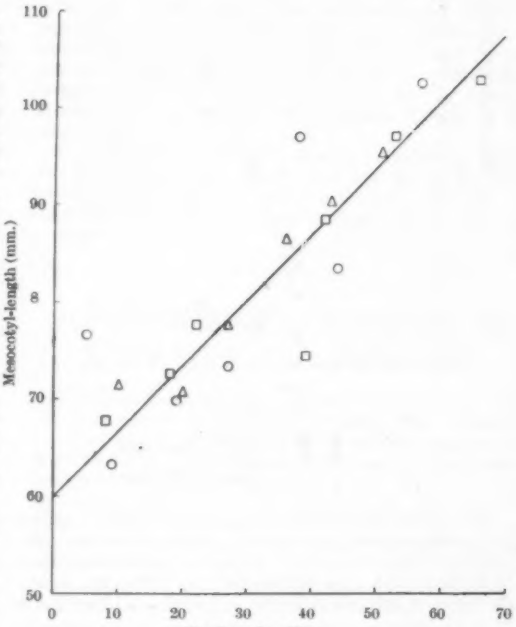


Fig. 1. ○—○—, Expt. 1; □—□—, expt. 2; △—△—, expt. 3

It was suspected that part of the effect of the presence of potassium hydroxide might have been due to the reduction in the humidity within the tin, which of necessity resulted from its use; but this was disposed of by including in the control tin a suitable solution of calcium chloride previously exposed for twenty-four hours to a 20 per cent carbon dioxide in air mixture to prevent the loss of the carbon dioxide produced by respiration of the plants by solution in the calcium chloride. This, consequently, would maintain the carbon dioxide content in the tin, and simultaneously reduce the humidity to a level comparable with that resulting from the use of potassium hydroxide.

Table 1

| | | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| *A* | No. of plants | 52 | 43 | 48 | 48 | 47 |
| | Mesocotyl-length | 76·9 ± 0·98 | 75·7 ± 1·26 | 86·2 ± 1·15 | 104·3 ± 1·79 | 72·1 ± 1·21 |
| | Coleoptile-length | 43·7 ± 1·85 | 39·7 ± 2·1 | 22·6 ± 0·78 | 44·9 ± 1·67 | 49·8 ± 1·37 |
| *B* | No. of plants | 51 | 42 | 49 | 49 | 49 |
| | Mesocotyl-length | 85·7 ± 1·43 | 83·8 ± 1·36 | 84·6 ± 1·07 | 76·8 ± 0·84 | 104·5 ± 1·47 |
| | Coleoptile-length | 41·8 ± 1·73 | 43·2 ± 1·89 | 20·8 ± 0·9 | 51·9 ± 1·48 | 52·8 ± 1·22 |

Fig. 2. ●—●, 5% $CO_2$; ●···●, control } mesocotyls; ○—○, 5% $CO_2$; ○···○, control } coleoptiles

The mesocotyls were again longer when grown in an atmosphere containing carbon dioxide; the lengths of two sets were: in the presence of potassium hydroxide 72·4 ± 0·88 and 68·7 ± 1·16 mm., in the presence of calcium chloride 101·4 ± 1·45 and 100·4 ± 1·21 mm.

In a further experiment plants were grown in a graded series of carbon dioxide concentrations to find if there were a corresponding gradation in mesocotyl-length. This was arranged by planting a different number of seeds in each of several tins: 5, 10, 20, 30, 40, 50, 60, respectively. The tins were then sealed with 'Plasticine' as previously. The results of three such experiments are shown in Fig. 1, in which mesocotyl-length at seven days, in mm., is plotted against the number of seedlings which germinated and grew in each of the tins. It is evident that there is a relationship between these two variables, and, combining all the results, the calculated regression line is $y = 59·9 + 0·67\,x$, where $y$ is mesocotyl-length and $x$ the number of seedlings. As the standard error of the second term (0·67) is 0·028 there can be no question that final mesocotyl-length is a function of the number of seedlings present, and presumably of the concentration of carbon dioxide in the tin.

Table 2

| | Controls | 1% $CO_2$ | Controls | 5% $CO_2$ |
|---|---|---|---|---|
| No. of plants | 47 | 47 | 51 | 47 |
| Mesocotyl-length | 56·5 ± 0·96 | 54·6 ± 0·97 | 56·0 ± 0·73 | 95·7 ± 1·21 |
| Coleoptile-length | 57·1 ± 0·77 | 55·0 ± 0·74 | 50·3 ± 1·17 | 29·5 ± 0·8 |

While these experiments were in progress, the necessary apparatus for growing plants in continuously flowing gas streams saturated with water vapour was assembled. A preliminary trial using 1 per cent carbon dioxide in air showed that this had no appreciable stimulatory effect, but a second with 5 per cent carbon dioxide was successful (Table 2).

Fig. 2 shows the result of an experiment using 5 per cent carbon dioxide, with air as control, in which sufficient plants were grown to take daily samples (which were discarded after measurement) from the third to the eighth day, and it is evident that there is a stimulating effect on the mesocotyl and the reverse on the coleoptile. The vertical lines shown on the seventh-day sample indicate the fiducial limits of variation of the means at $P = 0·01$.

The reduction of coleoptilar extension found in the gas stream experiments was not consistently noted in previous experiments with sealed tins, this being probably due to the fact that, in the latter, carbon dioxide concentration was only gradually built up to the effective level, whereas in the former a high concentration was present from the beginning.

An interesting conclusion may be drawn from the regression equation; for when $x$ (the number of seedlings in the tin) approaches zero and there is then no stimulating effect, the minimum length of the mesocotyl becomes 59·9 mm. The average length of the mesocotyls of all the controls (199 plants) in the gas flow experiments so far carried out is 61·4 mm., which closely approximates to the theoretical value.

It may also be mentioned that a preliminary experiment has shown that the inhibiting effect of light on mesocotyl growth takes place quite normally in the presence of a stimulatory level of carbon dioxide.

The investigation is proceeding.

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## THE BOSE INSTITUTE, CALCUTTA

THE thirty-second anniversary meeting of the Bose Institute was held on November 30, under the presidency of H.E. Dr. K. N. Katju, Governor of West Bengal, when Dr. K. C. Mehta, principal of, and professor of botany in, Agra College, Agra, delivered the eleventh Acharya Jagadish Chandra Bose Memorial Lecture on "Control of Rust Epidemics of Wheat in India: a National Emergency".

In presenting his report, the director, Dr. D. M. Bose, reviewed the principal events of the past year. He stated that to meet the increased demand for additional accommodation the construction of a laboratory of floor space 5,400 sq. ft. area, above the Hall of the Institute, was being undertaken immediately, at an estimated cost of Rs. 100,000. The trustees of the Sir J. C. Bose Trust have generously placed at the disposal of the Governing Body of the Institute a donation of Rs. 50,000, to be known as "Sir J. C. Bose Contribution", towards the furtherance of the objects of the Institute and which the Governing Body has earmarked for the construction of the proposed laboratory. To meet the balance of the cost of construction the Government of West Bengal has been approached for a capital grant of an equal amount. This total amount will not be sufficient to equip the

laboratory completely; a hope was expressed that other donations will be forthcoming for this purpose. The Director outlined further the building programme of the Institute. The Government of India has given a non-recurring grant of Rs. 100,000 for implementing some of the recommendations of the Reviewing Committee which, at the instance of the Central Government, visited the Bose Institute during March 1948. This amount is being utilized for the purchase of necessary workshop machinery and scientific apparatus. He announced that intimation has been received of a grant of Rs. 60,000 for a three years investigation on X-ray irradiation of oil seeds with the view of obtaining new mutants with improved economic characters. A grant of Rs. 6,000 has been received from the Burmah Oil Company (India Concessions), Ltd., for certain palæobotanical investigations which may throw some additional light on the controversial topic of the age of the Saline Series in the Salt Range, Punjab. Other grants received have raised the total amount to more than the present recurring grant of Rs. 100,000 received from the Central Government.

In reviewing the research work of the Institute, the Director mentioned that special importance is being given to the training of the younger research workers in modern technical methods like the use of high-frequency techniques of powerful sources of ultrasonic vibration, paper chromatography and of radioactive tracers. He referred to an interesting result observed in January 1949 of an increase in cosmic ray intensity associated with an intense sunspot activity. This phenomenon is of rare occurrence and not expected to be observed at the low geomagnetic latitude of Calcutta. He mentioned that a monograph will soon appear in the *Transactions* of the Institute in which the Founder's plant physiological investigations in relation to modern biological knowledge is reviewed. This year special attention is being given to the Founder's investigations on the responses in the living and the non-living.

In dealing with "Control of Rust Epidemics of Wheat in India: a National Emergency", Dr. K. C. Mehta said that in the greater part of the wheat area of India all the three rusts, black, brown and yellow, occur every year, and the black and yellow rusts also attack barley. The alternate hosts of black and brown rusts in temperate countries are of little consequence in India, and no such host has yet been found for yellow rust.

In the plants, in general, the spores that are responsible for the spread of the disease on the crop are killed soon after the harvest owing to intense heat of summer, and there is no local source of infection from the previous crop. This applies to more than 95 per cent of the wheat acreage in India. In contrast with this, all the three rusts are able to over-summer at different altitudes in the hills, which occupy scarcely 5 per cent of the entire wheat area, on 'out of season' plants. These plants 'carry over' the disease to the following crop in the hills, and rust is then blown down by wind to the plains. It is a clear case of re-introduction of the disease, year after year, from the source, that is, the hills.

Rust spores have been caught from the air at a large number of stations two to four weeks before the appearance of rust on the local crop; spores have also been caught on kites, hydrogen balloons and aeroplanes, in the last case even at an altitude of 10,000 ft.

Reckoned at current prices of wheat and barley, the approximate annual loss caused by rust comes to 200 million rupees, and in the event of a serious epidemic over large tracts of the country this figure may be doubled or even trebled, as happened in 1947.

The best method of controlling rust in the long run is to cultivate resistant varieties, and the breeding of such varieties has been in progress since 1935.

Without prejudice to the trial of partially resistant wheats in the meantime and until such time as suitable varieties are available, Dr. Mehta is convinced that a short-term plan to prohibit the *summer* crop in the hills, hilly tracts and plains of Peninsular India is essential in order to check the early outbreaks of rust in that part of the country. For control in the northern plain and the central parts, wheat and barley should be replaced by oats, fit for human consumption, as oats are not affected by any of the wheat rusts.

The adoption of these measures, intended to tackle the parasite at the source, has become a national emergency in view of the drive for self-sufficiency in food by 1951, when import of food grains is to be stopped.

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## ELECTRONIC INSTRUMENTS IN RESEARCH AND INDUSTRY

THE second symposium on electronic instruments in research and industry, which was organised by the Electronics Group of the Scientific Instrument Manufacturers' Association, was held in the Examination Hall, Queen Square, London, W.C.1, during November 2–4. The first Symposium (see *Nature*, 163, 294; 1949) was something of a venture, but its success was sufficient evidence that a regular function of this nature would be welcome. The organisers were, no doubt, encouraged in this view, for the scope was widened this year to include an exhibition supported by the majority of the member firms.

The symposium was opened by Sir George Thompson, who emphasized the facile manner in which electronic devices can be used for inspection, criticism and control. The first session consisted of a paper by Dr. Denis Taylor (Atomic Energy Research Establishment) on "Electronic Instrumentation in Atomic Research". Dr. Taylor outlined the use of electronic controls to maintain a specified power-level in an atomic pile and of the safety devices which ensure a complete shut-down in case of failure in any part of the system. In the measurement of radioactivity electronic devices hold a unique position, and Dr. Taylor described some of the elegant methods used for this purpose. These included monitors for checking personnel, laboratories and effluents, and a counter for the use by the modern 'forty-niner' prospecting for radioactive ores. The author emphasized that when dealing with radioactive substances no mistakes are permissible, and any device used in this field must be absolutely foolproof. The paper concluded with demonstrations of most of the items which had been described.

The next session was devoted to amplifiers, and papers on "Electronic Amplifiers" and "Magnetic Amplifiers" were read by I. L. Banks (Furzehill Laboratories, Ltd.) and A. V. Hemingway (Elliott Bros., London, Ltd.) respectively. The former dealt particularly with D.C. amplifiers and the physical factors which affect their performance in various applications. Mr. Hemingway explained the operation

of the simple magnetic amplifier and showed a graphical method, analogous with that using the dynamic characteristic of the thermionic valve, for deducing the overall performance as a function of load and supply conditions. He then discussed feed-back circuits and cascade operation and the effect of various factors on response time, pointing out that in the case of cascaded amplifiers this can be less than the sum of the individual response times. The author outlined the advantages of the magnetic amplifier in certain applications and concluded with descriptions of some typical cases.

Opening the next session, C. H. W. Brookes-Smith and J. A. Colls (Southern Instruments, Ltd.) read a paper on "Some Recent Improvements in Electronic Measuring Techniques" which dealt with the measurement of pressure, stress, strain and displacement. They explained the frequency modulation system using a variable capacitance or inductance pick-up, which permits static calibration, is insensitive to random amplitude variations and which can have a level response up to 30 kc./s. The difficulties encountered in the design of a pick-up were discussed, and some types under development were described in detail. The authors pointed out that this system and the wire-resistance strain gauge cover most of the requirements of engineers and research workers. A compact drift-corrected D.C. amplifier was described which is intended for use with either system.

Dr. H. A. Dell (Mullard Electronic Instruments, Ltd.) closed the session with a paper on "The Measurement of some Transient Phenomena", transient being defined here as applying to events of short duration repeated at regular intervals. Two examples were given which illustrated some of the problems encountered in the design of equipment for the visual delineation on a cathode-ray oscillograph of such events having low and high recurrence-frequencies respectively.

The first example was a precision polarograph for chemical analysis work using a mercury dropping electrode. The voltage across the cell during the life of each drop is compared with a calibrated standard by means of a vibrating switch, and the result is presented on an oscilloscope with suitable afterglow characteristics. Dr. Dell's second example was that of a high-speed oscillograph for the examination of radar systems and the like, in which the period between successive events is long compared with the duration of a single event. Some circuits were described which fulfil the necessary time-relationship and which can present any selected portion of the wave-form under examination.

In the final session the first paper, entitled "An Industrial Servomechanism", by P. H. Briggs (Ferranti, Ltd.), gave details of an automatic control system for accurately guiding cloth being fed on to a pin stenter or drying machine; this could be applied to certain other processes, such as paper manufacture, involving a continuous web of material. Any lateral motion of the edge of the web is detected by a photocell and the necessary correction applied by a servo device, precautions being taken to ensure a quick response with freedom from hunting. The whole equipment is designed to operate under the conditions normally encountered in a textile mill and can be worked by relatively unskilled personnel, there being only one control knob to adjust. A commendable feature is that the electronic circuit, which is of simple design, can be used in other applications.

Dr. A. J. Maddock (British Scientific Instrument Research Association) read the final paper, which was entitled "Co-operative Research at B.S.I.R.A.". He traced the history of the Association from the early days when it was concerned mainly with the problems of the optical industry, although investigations were made in other fields, two such being the production of phosphors for cathode-ray tube screens and a study of the magnetic susceptibility of the materials used for galvanometer suspensions. During the Second World War notable contributions were made to the production of graticules and to the anti-reflexion treatment of optical surfaces. The Association has recently expanded to seven departments in new premises at Chislehurst. Dr. Maddock described the facilities now available, with special reference to the Electricity and Electronics Departments, where work is in progress on such items as voltage stabilizers, D.C. and magnetic amplifiers, thermo-magnetic materials and on thermionic emission.

The session concluded with a summing-up by Mr. A. J. Philpot, the director of the Scientific Instrument Manufacturers' Association, who said that the symposium had in every sense satisfied the dictionary definition of the word, and that it had now firmly established itself in the calendar with every promise of increasing success in the future.

## RHEOLOGY OF EMULSIONS

A JOINT meeting of the British Rheologists' Club and the Faraday Society was held at the Institute of Physics, 47 Belgrave Square, London, S.W.1, on November 11, Dr. G. W. Scott Blair being in the chair.

Dr. C. G. Sumner opened the discussion. He pointed out that the rheological behaviour of emulsions has much in common with that of suspensions, but certain distinctive features arise. By the use of suitable emulsifying agents, either of a given pair of immiscible liquids may be dispersed in the other, and the formation of droplets from bulk liquid is a hydrodynamic process into which the viscosities of both liquids enter. When an emulsion is caused to flow, deformation of the droplets may occur, which will reduce the apparent viscosity of the emulsion as a whole. It is doubtful whether any of the usual emulsifying machines breaks up only the liquid to be dispersed; generally both liquids are dispersed, and the effect of the emulsifying agent is seen mainly in the subsequent coagulation process; droplets of one liquid are prevented from coalescence while the others are not. In both dispersion and coagulation processes, the mechanical treatment and the relative volumes, viscosities, densities and boundary tensions of the liquids are important factors, but their precise interrelation cannot be specified. Taylor[1] recorded photographically the elongation of a single drop of liquid subjected to viscous drag in a second liquid, finding the effect of the viscosity of the drop relative to that of the external liquid to be striking, and some of his observations were afterwards given a mathematical basis by Timotika[2]. From Clay's[3] experiments it appears likely that the bursting of droplets in turbulent flow takes place by a mechanism similar to that in the jet of an oil atomizer. The chances that a drop will burst decrease rapidly with the radius of the droplet below a certain value.

Regarding the stability of emulsions, there are three ways in which the system can become less homogeneous: (i) by 'creaming', that is, by concentration of globules of the disperse phase towards the top or bottom of the emulsion; (ii) by clumping of individual globules without coalescence; (iii) by coalescence of globules to form larger drops and eventually bulk liquid. Only the third represents instability in the sense of a reversal of the emulsification process; but creaming may be objectionable and is usually minimized by fine dispersion and the addition of thickening agents to the external phase. Such thickening agents are generally materials which form viscous or thixotropic sols with the dispersion medium. There seems no doubt that the viscosity of the emulsion as a whole is closely related to the ease of emulsification, and the implication is that in the most stable emulsions the globules have a sufficiently low residual interfacial energy against the external phase to be substantially independent of one another. From the practical point of view, an emulsion with some tendency to thixotropy will be preferable to one with the minimum resistance to flocculation, since the latter will cream more readily. With certain emulsifying agents the stability of the emulsion obtained is dependent on the relative volumes of the phases, the concentration of agent and the mechanical treatment of the emulsion. Such systems are prone to show phase-type inversions or multiple emulsions, with abrupt changes in viscosity.

Most of the published work on the viscosity of emulsions has been carried out in connexion with the testing of equations relating the viscosity of an emulsion to that of the dispersion medium. Of such equations may be mentioned those of Taylor[4], Leviton and Leighton[5], Richardson[6], Broughton and Squires[7] and Hatschek[8]. A comprehensive series of experiments to test Hatschek's conclusions has been made by Sibree[9], who finds poor agreement between observed and calculated values, although an improvement in the equation may be effected by the introduction of a 'volume factor'. This is confirmed by Gabriel[10]. Richardson[6] has developed an equation connecting apparent viscosity at an arbitrary rate of shear with the volume concentration. The work of Broughton and Squires[7] has given a clear demonstration of the importance of the emulsifying agent in determining the viscosity of the emulsion. The works of Toms[11], Lyttleton and Traxler[12] and Eilers[13] is also of interest in this connexion. No quantitative theory appears to have been advanced to account for the observed dependence of the viscosity of emulsions on the mean globule-size or the size distribution; homogenization of an emulsion increases its viscosity, sometimes considerably.

Our knowledge of this subject is still sketchy, Dr. Sumner concluded. In the past there has been a tendency to treat the flow of emulsions as an operation in solid geometry and mechanics; but it is now clear that the rheological behaviour is intimately connected with the nature of the interfacial film or phase, and the influence of globule-size distribution is more important than has hitherto been supposed.

In the ensuing discussion, Dr. A. H. Nissan mentioned that the constant of 2·5 in all the equations referred to is simply the value for the most probable range of globule-sizes. The size-range is important, and for uniform globules the constant may be as much as 4·3. Dr. Scott Blair remarked that Anstein and Reiner had shown that the Einstein law, including the 2·5, holds for cement mortars of viscosity about $10^{17}$. Mr. A. de Waele directed attention to the fact that the equations of Richardson and of Broughton and Squires are approximations for the case when the viscosity ratio is nearly unity; some workers have lost sight of this and used them when the viscosity ratio is ten or more.

## Milk as an Emulsion

Dr. R. Aschaffenburg continued with an account of "Milk as an Emulsion". Milk consists of an aqueous phase containing salts, lactose and colloids (mainly proteins) into which is dispersed fat. Though perhaps the most perfect single food, milk is not perfect as an emulsion because of its tendency to 'cream', which, however, may be overcome by homogenization. The slow break-up of this emulsion is possibly an aid to digestion. The size of the fat globules varies from 0·1 $\mu$ to 10 $\mu$; the size distribution depends upon several factors. The number of globules is very large: the weekly three-pint non-priority milk ration in Britain contains about five thousand billion globules. Apart from creaming, the emulsion is stable, and it is not possible to extract the fat directly with solvents. About 1840 Ascherson suggested that this was due to a 'membrane' around the fat globules, and subsequent work, especially by L. S. Palmer, has confirmed this view. Electron microscope pictures of the fat globules, indeed, show each one surrounded by a dark layer and a hazy region, but the interpretation of such pictures is still the subject of much controversy.

The rising of cream is predominantly an effect of gravity, but, on account of clustering of the globules, the rate of rise is greater than would be expected from Stokes's law. Clustering is due to the presence, in milk, of an 'agglutinin' which, like bacterial agglutinins, is of a globulin nature.

Butter is now prepared by three main processes: (i) the classical method of churning, (ii) by the preparation of cream of a much higher fat percentage (about 80 per cent), followed by cooling and mechanical working, (iii) by the preparation of the 80 per cent fat cream, its conversion to pure butter oil and subsequent emulsification with the right amount of water, whey or skim milk. The classical method is a kind of flotation process with foam enrichment; it works best when the fat is neither completely 'solid' nor completely 'liquid', but it is not known why this should be so. Milk has a minimum foam stability at 20–30°, which has been shown to be due to the fat. Butter is not a straightforward oil–water emulsion, and its rheological properties vary with the method of manufacture. These properties offer an interesting field for further research.

## Formation and Flow of Emulsions

Dr. E. G. Richardson, in a paper on "The Formation and Flow of Emulsions", said that there are two basic processes of emulsion manufacture. Either one liquid is squirted into another, or the two liquids are allowed to mix in turbulent motion. The first is the problem of the break-up of a liquid under the combined actions of the interfacial tension and the relative viscosity. In the main there are three types of such disintegration. In the first type, the jet becomes varicose. Rayleigh[14] has examined the conditions for this to take place, and Tyler and Richardson[15] have taken photographs of this type of break-up from capillary jets. In the second type, the jet becomes sinuous, and the resistance to the passage of the 'humps' becomes more important than the

surface tension. This type has been dealt with mathematically by Weber[16], and both Tyler[17] and Ohmesorge[18] have given criteria for the critical velocities for the change from the varicose to the sinuous forms. At high velocities in excess of the critical value, break-up is controlled by viscous and inertial forces. At low speeds, drops are formed when the varicosities acquire an amplitude sufficient to nick off the jet, and so tend to be of uniform size; whereas at high speed the drops are formed as 'lumps' sheared off the periphery and tend to show a greater dispersion of size.

Dr. Richardson showed photographs of jets and the results of drop-size measurements for jets of aniline, paraffin and oil, and benzene into water for different nozzle sizes and velocities. When jets issue from *large* nozzles at *low* speeds, the drops tend to oscillate about the spherical shape and eventually to burst into fragments. Such effects of deformation and circulation have been investigated by Bond and Newton[19], and Taylor[4] has obtained an expression for the upper limit to the size of drop which can subsist while the fluid is being sheared. It is also possible to influence drop-size by acoustic agitation, and it appears that ultrasonic agitation can be used to produce greater fineness and uniformity of dispersion.

Regarding the flow of an emulsion, once formed, the viscosity is affected by (i) concentration of dispersed phase, (ii) drop-size distribution, (iii) rate of shear. In most practical emulsions the drops are so small that they act as rigid spheres when the emulsion is sheared. Experiments with benzene and water show that the viscosity increases rapidly with the concentration of the disperse phase, such that

$$\log \eta/\eta_0 = \chi c,$$

where $\eta$ and $\eta_0$ are the viscosities of emulsion and 'solvent', $c$ is the concentration and $\chi$ is a sort of 'interphasal' compressibility. Broughton and Squires[7] write

$$\log \eta/\eta_0 = \chi(c + c_0),$$

where $c_0$ is an intercept on the axis.

The variations of viscosity can be given a partial explanation by supposing the process of shearing the emulsion to cause one row of globules to pass over another row. Slow motion will cause an upper row to pass over a lower row through a series of 'humps'. At higher rates of shear, the upper globules are supposed to 'jump' over the lower depressions without falling right in, and the viscous traction concerned in lifting them out of the 'hole' is less. Unpublished experiments by Iskander and Richardson on the effect of globule-size on viscosity show that the limiting viscosity at the highest rates of shear is roughly inversely proportional to the mean globule-size.

In the discussion on this paper, Mr. A. K. Soper took exception to the Broughton and Squires equation involving an intercept $c_0$ on the axis; Dr. A. S. C. Lawrence said that there was some evidence for the existence of an elastic skin around the globules. Mr. de Waele said that in solid–liquid systems there appears to be such a barrier, for the difference between the theoretical packing limit of 74 per cent for uniform spheres and the actual practical limit may be considerable. With a certain carbon black (0·03 $\mu$–0·20 $\mu$) it is impossible to get more than 20 per cent into oil, and the product is not thixotropic —it fractures like a solid. With $\frac{1}{2}$-$\mu$ particles one gets nearer the theoretical 74 per cent limit, and then only does the phenomenon of dilatancy arise. The existence of a barrier layer would increase the stability of an emulsion.

Mr. J. E. Adamson remarked that globule-size distribution should be specified more precisely: in the simplest case of a Gaussian population, two factors are required (mean and standard deviation), and with more complicated distributions the moments about the mean must be considered. Dr. A. H. Nissan said that the flow of water through glass filters at various temperatures cannot be accounted for by viscosity effects alone, but one can get similar effects by adding materials which change the surface tension. This may be due to the formation of a surface layer on the glass which interferes with the normal mechanism of flow. Dr. W. H. Banks denied this, and said that it is very difficult in such experiments to be sure that the glass is not swollen; the electro-viscous effect must be taken into account.

V. G. W. Harrison


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## GENETICS AT THE UNIVERSITY OF GLASGOW

WITH the recent opening of new premises for the Department of Genetics, the development of teaching and research in genetics at the University of Glasgow has gone a step further. Of the two floors of the building, the top one is for research and can accommodate up to ten research workers in small laboratories; the ground floor is reserved for undergraduate teaching and has laboratory accommodation and services for up to fifteen students.

The research laboratories are suitable for any kind of genetical research with plants or animals, though the equipment has been chosen mainly in view of expanding the work with micro-organisms, the field of genetical research which has been in the forefront in Glasgow since 1943. The long-term line of research in the Department is an approach to the spatial–temporal organisation of biochemical processes in the cell, using the biochemical genetics of micro-organisms as a tool. Of the innumerable problems arising from this approach, those under actual investigation at present include the formal genetics of *Aspergillus nidulans* (a first systematic attempt to work with a homothallic species); the cytogenetics of a mycetozoon; the study of nuclear and cytoplasmic control of 'adaptive' enzyme systems; and the biochemical genetics of those biosyntheses which involve steps of millimicromolar order. Some of these problems have obvious implications for applied fields, for example,

pathology, industrial fermentations, etc., and their investigation has received support in the form of research grants, scholarships or fellowships from the Medical Research Council, the Department of Scientific and Industrial Research, the Agricultural Research Council, the Carnegie Trust for the Universities of Scotland, the Brewing Industry Research Foundation and the Research Department of the Distillers Company, Ltd. The present number of graduates, including staff, engaged in research is eight.

As for the undergraduate teaching in genetics, the University of Glasgow has embarked on a bold experiment. The establishment in 1945 of an independent lectureship in genetics, soon after to become a Department, meant that it was realized that the teaching of this subject cuts across the traditional main partition of the teaching of biology into botany and zoology; in other words, the fundamentals of genetics (though not necessarily advanced study) must be taught in the same way to all students of biological subjects. Turning this consensus into practical application requires considerable adjustments in regulations, time-tables, curricula, etc., besides the building up of teaching staff and the organisation of lectures and practical classes: it has taken about four years to do this, and the present position of the teaching of genetics in the Faculty of Science is as follows. Instruction in genetics has been removed from the courses in botany or zoology; but students intending to read for honours in either subject are advised to take Course I in genetics as a subsidiary. Genetics has been included among the subjects for both ordinary and honours B.Sc. The honours curriculum includes three courses (I, II and III), each extending over three terms; Course I (70 lectures and 60 practical classes) can also be taken by any student in the Faculty of Science who has already passed first-year botany or zoology; Courses II and III can be taken only in combination with an honours curriculum in botany, or zoology, or biochemistry or physiology, the minimum time for such combined honours being four years.

It will take a few years to tell whether the solution adopted at Glasgow has been a wise one, and no doubt experience will suggest modifications.

## ROYAL SOCIETY INFORMATION SERVICES COMMITTEE

IT is already clear that the outcome of the Royal Society Scientific Information Conference in June–July 1948 will be much more than the admirable volume recording its proceedings and recommendations which followed. To carry out these recommendations and to implement the work of the Conference generally, the Council of the Royal Society set up an Information Services Committee, under the chairmanship of Sir Alfred Egerton, and this Committee held its first meeting on November 23, 1948. One of the first acts of the Committee was the establishment of an Abstracting Services Consultative Committee, an account of the work of which, by its chairman, Dr. G. M. Findlay, was recently published in *Chemistry and Industry* (819; 1949). This has since been followed by an official report of the activities of the Information Services Committee itself for the year ending October 31, 1949. Besides this, the Lord President of the Council, on accepting the invitation of the Scientific Information Conference to consider improvements in the national central scientific libraries and information services, called upon the Panel on Technical Information Services of the Committee on Industrial Productivity to review the situation and make recommendations. The Information Services Committee is already considering a report from the Panel entitled "Report on Scientific and Technical Library Facilities", while there has also been published in the *Library Association Record* of December 1949 a report on "The Co-operative Provision of Books, Periodicals and Related Material" from a 'working party' on library and information services, set up by the Council of the Library Association in January 1949 at the request of its University and Research Section.

This latter report, which is in two parts, the second outlining a basic plan for a national library service, comprising the national libraries, a series of first-line and a series of second-line special libraries, major regional reference libraries, and lending libraries, and involving as a first stage the compilation of a directory of libraries in Great Britain and Northern Ireland, including a survey of specialist resources of all libraries, has already been forwarded both to the Royal Society and to the Information Services Panel. The Council of the Library Association has also asked the 'working party' to hold discussions with representatives of the British Museum, the National Central Library, the National Committee on Regional Library Co-operation, the Science Library and Aslib, and to compile a pilot survey in engineering and the fine arts to ascertain the probable extent of co-operation and estimated additional expenditure to obtain complete coverage. A more detailed report is then to be prepared on the basis of this survey, and it will be noted from the report of the Information Services Committee that that Committee has already welcomed the co-operation of the Library Association in this field.

The recommendations of the Royal Society Conference are set out in a paper issued by the Royal Society on August 5, 1948, and this has been the basic working paper for the Committee. The recommendations were classified by the Committee into eight groups, according to subject-matter and then again according to whether they could be committed for action to various specified bodies, whether they required further study by individual members of the committee with the view of recommending action later, or whether they required wider investigation by sub-committees or by the Committee as a whole. Co-operation has also been secured from overseas delegates and the organisations they represented, and whenever appropriate with the United Nations Educational, Scientific and Cultural Organisation. A major part of the sixth meeting of the Committee was devoted to the brief of the British delegation to the Unesco Conference on Science Abstracting in Paris in June 1949.

As regards the other general recommendations, proposals have been made for the initiation of further research into the use of scientific literature, but no specific programme has been begun. A sub-committee has collected from some fifty scientific publishing bodies their instructions to authors, and has drafted a concise general pamphlet which is being submitted for informal comment and which the Information Services Committee proposes to invite the Council of the Royal Society to authorize for issue to universities, government and industrial research establish-

ments in the hope that younger scientific men in particular may be assisted thereby to improve the writing of scientific papers.

Comments of scientific societies on a recommendation that funds should be made available to provide facilities for the work of editors and publication boards have led the Committee to recommend to the Council of the Royal Society that efforts should be made to obtain an increase in the Parliamentary grant-in-aid of scientific publications administered by the Society, and to extend its scope to cover additional editorial staff and facilities as well as printing costs. The Biological Council has been invited to report on the effectiveness of its calling together the editors of periodicals dealing with the biological sciences with a view to similar collaboration elsewhere, but the suggestion regarding the publication of précis journals was not welcomed. The action taken in regard to fair copying has already been reported in *Nature* (164, 289; 1949).

The Abstracting Services Committee believes that improvement is possible in the preparation of authors' summaries or synopses, and has accordingly prepared a leaflet, "Guide for the Preparation of Synopses", which has been sent to scientific societies and other publishers of scientific journals with two recommendations endorsed by the Council of the Royal Society. These recommendations, that every paper in a scientific journal should be accompanied by a synopsis or précis, independent of the text and figures, and preferably at the beginning of the paper, and that these synopses should be subject to the same editorial scrutiny and correction as the full paper, have been copied by Unesco, and the leaflet has been in extensive demand. The Committee also supervised the compilation of a comprehensive list of journals, etc., containing abstracts, and this was issued in June 1949 (see *Nature*, 164, 692; 1949). The British delegation to the Unesco Conference on Scientific Abstracting consisted of Dr. C. H. Desch, Dr. L. H. Lampitt and Mr. K. T. Pledge, and at the Conference the suggestion that the model of the Abstracting Services Committee should be followed elsewhere was adopted. Following a survey of the practice of more than one hundred British abstracting journals, the Abstracting Services Committee is inviting all abstracting agencies to co-operate towards the general adoption of a standard method of quoting references which the Committee has drafted. Consultation with scientific societies also showed that many societies which do not at present publish the titles of new papers accepted for publication before the papers appear in print have indicated their intention to do so in the future.

The Information Services Committee has also formed a sub-committee under the chairmanship of Prof. J. D. Bernal for further study of classification, but while a specific recommendation relating to the evaluation of new alternative systems of chemical notation has been referred to the International Union of Pure and Applied Chemistry, no significant developments are reported in mechanical methods of indexing and selection. The recommendation that the Publishers' Association be invited to arrange the issue of suitable unit catalogue cards for all British scientific and technical books is considered to have been satisfied by the scheme to be introduced by the British National Bibliography. The Committee is unable to act directly on most of the recommendations relating to aids for information services but has forwarded them to the authorities concerned. Thus, the Federation of British Industries was invited to prepare a directory of industrial research, and the Department of Scientific and Industrial Research to issue a directory of centres of highly specialized research. The Committee has accepted the recommendation of the Panel on Technical Information Services that compilation and publication of a comprehensive index of research activities and specialized knowledge of individual scientific workers is inadvisable at present. An exhaustive study of the need for improved special dictionaries and the fixing of interlingual equivalents for scientific terms has been made by Dr. J. E. Holmstrom, and the results are incorporated in a report issued by Unesco. In this report, which is provided with a bibliography giving particulars of 550 interlingual dictionaries, Dr. Holmstrom suggests that the efforts at present being made to standardize technical terms should be co-ordinated under an International Terminological Bureau to be established by Unesco which, besides conducting research, would maintain relations with all the federations and societies concerned and provide central services. The Bureau would collect and index definitions and technological equivalents which have been used or proposed by individual translators but have not yet been included in known dictionaries, and would issue them to inquirers on demand. It would also offer such definitions and equivalents for official approval as occasion arose, and the approved definitions and equivalents when printed would be distinguished by a suitable symbol to indicate this official approval.

The Information Services Committee has experimental evidence of the value of an agency equipped with special typing facilities, and warmly supports a proposal which has been submitted to the Royal Society, especially for dealing with the acute letterpress difficulties that arise in the field of mathematics. The Committee decided to delay action on the recommendation that permanent relations be established with representative printing organisations until the effect of improvements which had reduced the delays in the publication of original scientific papers could be assessed, but has recommended the formation of a small consultative committee with representatives from the British Federation of Master Printers and the Printing and Kindred Trades Federation. It has also encouraged the publication of an article on photographic methods of documentary reproduction, and recommended that the Department of Scientific and Industrial Research should initiate and encourage research on methods of photo-copying which do not require the use of silver salts, and especially of methods making it possible to obtain reductions and enlargements.

## SUPPLY AND DEMAND FOR PROFESSIONAL ELECTRICAL ENGINEERS

A GROUP of sub-committees under the general direction of the Technical Personnel Committee has been engaged for a period of some two years in carrying out a comprehensive survey of the probable future demands in Great Britain for professional personnel in the various branches of science and engineering. The report of the Electrical Engineers' Panel of the Engineering Sub-Committee has recently been published (London: H.M. Stationery Office,

6d. net). The Panel was under the chairmanship of Sir Arthur Fleming, who has an intimate personal knowledge of the employment of professional electrical engineers in manufacturing industry extending over a long period.

The scope of the investigation covered the assessment of the requirements of the main divisions of the profession and a comparison of this estimate with the existing supply. The estimated annual demand over the next five years is summarized as follows.

| | |
|---|---|
| Public service (including the Armed Forces, government departments and public bodies such as the National Coal Board and British Electricity Authority) | 660 |
| Industry (including research associations) | 900 |
| Teaching (universities and technical colleges) | 50 |
| Consultants | 10 |
| Emigration and miscellaneous | 50 |
| | 1,670 |

The annual supply up to 1950 is estimated at 1,550, made up as follows.

| | |
|---|---|
| University output | 500 |
| From full-time courses in technical colleges | 150 |
| Higher National Certificates (credit standard) | 600 |
| Miscellaneous (including entry by the examinations of the Institution of Electrical Engineers) | 300 |
| | 1,550 |

There is thus an estimated annual deficiency of the order of ten per cent. It is concluded that, as there is good ground for expecting an increase of output from the universities and technical colleges, resulting in the main from the substantial building programme which is in progress and the increase in the number of available scholarships, the deficiency is likely to be met by the provisions already in hand. The opinion is expressed that the requirements of industry generally "tended to be higher in the immediate future than was likely to be the case in subsequent years".

While the report is concerned specifically with professional engineers, an interesting incidental comment is made in regard to technicians. In general terms, the distinction between the professional engineer and the technician is made in respect of the professional engineer's ability to take personal responsibility for development in electrical engineering, while the technician will normally carry out technical work in accordance with established practice or under direction. It is estimated that the average ratio of the number of technicians to the number of professional engineers will be of the order of five to one. The report does not consider the adequacy of the supply of technicians, but it may be remarked in passing that there is evidence of a distinct shortage of this class of personnel.

While, as the report points out, no claim can be made for the accuracy of the estimates given, this document constitutes a valuable summary of informed opinion upon an important subject.

## CORRECTED KRYPTON WAVE-LENGTHS

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I USED a reflecting echelon to measure vacuum wave-lengths of thirty-one lines in the arc spectrum of krypton in terms of the cadmium red standard[1]. The dispersion formula of Barrell and Sears[2] and of Perreau[3] for pure air and carbon dioxide respectively were used to calculate the wave-lengths in 'normal' air (air at 15° C. and 760 mm. pressure containing 0·03 per cent carbon dioxide). These were found to differ appreciably from those recommended by the International Astronomical Union, although very close agreement was obtained when the dispersion formula due to Kosters and Lampe[4] or Perard[5] was employed. Barrell and Bruce have pointed out that this discrepancy lies outside the error which could be attributed to difference between the three dispersion formulæ, and further examination has revealed an arithmetical error in the application of the dispersion formula of Barrell and Sears.

The amended wave-lengths in 'normal' air are tabulated herewith, being calculated by each of the three dispersion formulæ. Where the International Astronomical Union wave-lengths are not available, Jackson's[6] are quoted and marked (J) accordingly. For simplicity, only fractional portions of wave-lengths are given in the last three columns. Each formula leads to a slightly different primary vacuum wave-length standard, since the wave-length of the cadmium red line 6438·4696 is specified in 'normal' air. Corresponding changes appear in the vacuum wave-lengths, and these are used in calculating the 'normal' air wave-lengths appropriate to each formula.

It will be observed that when the calculation is carried out in this way, differences between 'normal' air wave-lengths obtained by each of the three dispersion formulæ do not differ by more than three in the fourth decimal place of an Angstrom unit. The mean difference between these wave-lengths and those of the International Astronomical Union is + 0·0003 A.; which is the order of the standard deviation of the vacuum wave-length measurements.

This work is being repeated using a more refined technique and at the same time being extended into the near ultra-violet. I am most grateful to Mr. H. Barrell, of the National Physical Laboratory, Teddington, and to Mr. C. F. Bruce, of the Australian National Standards Laboratory, Chippendale, N.S.W., for their assistance in this matter.

| International Astronomical Union | Barrell and Sears | Kosters and Lampe | Perard |
|---|---|---|---|
| 4273·9700 | 0·9703 | 0·9703 | 0·9704 |
| 4282·9683 | 0·9681 | 0·9681 | 0·9682 |
| 4286·4873 | 0·4869 | 0·4869 | 0·4870 |
| 4300·4877 | 0·4861 | 0·4861 | 0·4862 |
| 4318·5525 | 0·5528 | 0·5528 | 0·5529 |
| 4319·5797 | 0·5805 | 0·5805 | 0·5806 |
| 4351·3607 | 0·3603 | 0·3604 | 0·3605 |
| 4362·6423 | 0·6420 | 0·6422 | 0·6423 |
| 4376·1220 | 0·1226 | 0·1227 | 0·1229 |
| 4399·9670 | 0·9673 | 0·9674 | 0·9675 |
| 4425·1906 (J) | 0·1904 | 0·1905 | 0·1906 |
| 4453·9179 | 0·9183 | 0·9184 | 0·9185 |
| 4463·6903 | 0·6906 | 0·6908 | 0·6909 |
| 4502·3547 | 0·3549 | 0·3550 | 0·3552 |
| 5562·2257 | 0·2279 | 0·2280 | 0·2281 |
| 5570·2895 | 0·2902 | 0·2903 | 0·2904 |
| 5580·388 (J) | 0·3888 | 0·3890 | 0·3891 |
| 5649·5628 | 0·5627 | 0·5628 | 0·5629 |
| 5672·4519 (J) | 0·4512 | 0·4514 | 0·4515 |
| 5707·512 (J) | 0·5127 | 0·5128 | 0·5129 |
| 5832·859 (J) | 0·8599 | 0·8600 | 0·8601 |
| 5866 | 9·7514 | 0·7514 | 0·7515 |
| 5870·9158 | 0·9168 | 0·9169 | 0·9170 |
| 5879·9000 (J) | 0·9003 | 0·9005 | 0·9005 |
| 5993·8503 | 0·8513 | 0·8514 | 0·8515 |
| 6012·1570 (J) | 0·1569 | 0·1571 | 0·1571 |
| 6056·1280 (J) | 0·1274 | 0·1275 | 0·1276 |
| 6082 | 0·8629 | 0·8630 | 0·8630 |
| 6236·354 (J) | 0·3519 | 0·3520 | 0·3521 |
| 6421·029 | 0·0285 | 0·0285 | 0·0285 |
| 6456·291 | 0·2910 | 0·2910 | 0·2910 |

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Flight Recorders: a Technique for the Study of Bird Navigation

In experiments on the homing ability of birds, it would obviously be a great advantage if one knew the actual time spent in flying by a bird which had been released some way from home and which had returned after a known time. Mere knowledge of the time between release and return can only provide an upper limit for the effort expended by the bird in regaining home: in practice, the real flying time may be very much less than this, and knowledge of it is vital in deciding for or against hypotheses involving search or some real navigational ability. Following the bird by light aeroplane has been accomplished[1]: this technique, though very powerful, is cumbersome and cannot cope with a homing flight of some days. Exner[2] has used a method dependent on the different rates of evaporation of camphor in still and moving air to measure the flying time, but this method is susceptible of only very limited accuracy; nevertheless it constitutes the first, and very early, attempt to measure the flying time.

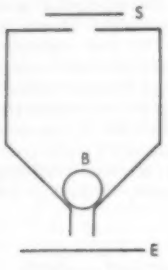


Fig. 1

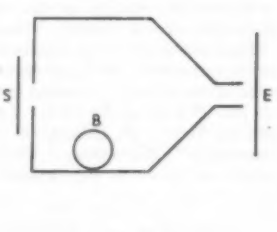


Fig. 2

An accurate measure of the flying time may be achieved using the instrument which is illustrated schematically in Figs. 1 and 2. *S* is a source of α-particles, *E* a piece of photographic emulsion and *B* a steel ball. The instrument is fixed to the bird in such a way that, when it is at rest, the orientation of Fig. 1 is assumed (to within 45°); the α-particles strike the steel ball and do not reach the emulsion. When the bird flies, the orientation of Fig. 2 is approximated to, *B* rolls out of the way and the α-particles strike the emulsion. If the emulsion is processed and examined under a microscope, the tracks of the individual α-particles may be very easily seen and counted, their number measuring the time for which the bird has been flying. The instrument has dimensions of roughly 8 mm. × 5 mm. and, when assembled, weighs 250 mgm. If an accuracy of 2 per cent or better is required in the knowledge of the flight-time, a ratio of 20 or so is permitted between the longest and shortest flight times: if the accuracy is 10 per cent, this factor rises to 500. Any time-scale from minutes to weeks may be catered for with equal accuracy. This instrument has been used on large-scale experiments on the homing of domestic pigeons (fixed to the wing). These experiments have been performed in collaboration with Mr. G. V. T. Matthews, whom I would like to thank for his help with the testing of the device.

Modifications of the method suggest themselves. Thus an instrument has been made and tested in which the α-particle source is mounted on a small inertia arm. This instrument records only flapping flight and not soaring or gliding. It is hoped to incorporate a compass card in such a way that the time spent flying in various directions should be revealed. A device recording the time spent on water could be constructed, the water filling a small absorption cell between the source and film.

Thanks are due to Dr. A. G. Maddock for help with the sources, to Mr. D. D. Stewart for his mechanical skill, and to Dr. C. Waller of Messrs. Ilford, Ltd., for supplying the emulsion.

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## A New Human Blood Group

During the investigation of a hæmolytic transfusion reaction, it was observed that the patient's serum contained an *iso*antibody the reactions of which did not correspond with those of known blood group systems. The patient was a hæmophilic who had received previous transfusions. His serum contained two immune antibodies, namely, anti-*Rh* and a second antibody which reacted with a large proportion of group *O Rh*-negative bloods; this second antibody could be detected with certainty only by the indirect Coombs test.

The patient's red cells were found to have the following characteristics: *O*, *cde/cde*, *MN.S*, *P+*, *Kell−*, *Lutheran−*, *Le(a− b+)*; it could be deduced that the patient possessed the $Le^a$ gene, since he secreted the $Le^a$ substance in his saliva[1]. It was theoretically possible for the patient to have formed the following antibodies outside the *Rh*-system: anti-*s*, anti-*p*, anti-*Kell* or anti-*Lutheran*. The patient's serum was tested against a large number of blood samples, in parallel with appropriate sera (anti-*S*, etc.); and it became clear that the antibody was reacting with a factor unrelated to these systems. The patient's serum has been tested against blood samples from 180 unrelated adults; 66 per cent of the reactions were positive. The incidence of positive reactions appears to be independent of the *ABO*- and *Rh*-group of the bloods tested.

The inheritance of the factor is being investigated. Families have been encountered where both parents possess the factor but produce offspring whose blood lacks the factor. It is therefore evident that the blood of heterozygotes reacts with the serum.

The following notation is proposed: the system may be called *Duffy* (by permission of the patient). Following the suggested notation for the Lewis group system[2], the antigen with which the patient's serum reacts may be called $Fy^a$, and this symbol may also be used for the gene determining this antigen; one may postulate an allele $Fy^b$. From our data the following approximate gene frequencies may be calculated: $Fy^a = 0{\cdot}41$; $Fy^b = 0{\cdot}59$.

A full account of these investigations will be published elsewhere.

We are grateful to Dr. G. Plaut, of the North London Blood Supply Depot, for a very large number of samples of *Rh*-negative blood; to Dr. W. J. T. Morgan for supplying anti-$Le^a$ and anti-$Le^b$ sera and for testing the saliva of the patient; to Dr. A. E. Mourant for supplies of some of the other rare sera; to Miss Elizabeth Ikin for testing the serum against a panel of human bloods, and confirming that it could not be reacting with any factor within the systems at present recognized; and to Dr. R. R. Race for advice on nomenclature.

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## Effect of Posterior Pituitary Extract and its Fractions on Renal Electrolyte Excretion

IT seems to be generally accepted that, in addition to its antidiuretic effect, posterior pituitary extract has a chloruretic action. All workers appear to have found an increase of chloride concentration in the urine; but there is by no means unanimity whether the actual amounts excreted are increased, results varying with the species and experimental conditions (see, for example, Shannon[1] and O'Connor[2]). Furthermore, it is not clear which of the posterior pituitary fractions is mainly responsible for the chloruretic effect, and which ions are excreted with the chloride.

Some observations on this subject have been recently published by O. Schaumann[3,4], who investigated the action of oxytocin and of vasopressin on the renal excretion of chloride, sodium and potassium ions in rats. We have been engaged in similar experiments. The effect of small doses (3 milliunits/100 gm. s.c.) of 'Pitocin', 'Pitressin' and 'Pituitrin' on the chloride excretion of hydrated rats was first investigated. It was found that the changes in the rate of chloride excretion obtained with 'Pituitrin' and 'Pitressin' coincided—as might have been expected—with the antidiuretic effect. The duration of the antidiuretic effect was therefore used to determine the urine-collecting period. The effect of the injection of posterior pituitary extracts on the rate of chloride, sodium and potassium ion excretion was then studied in rats on standard and sodium chloride-enriched diets.

| | K | | Na | | Cl | | Unknown ions | |
|---|---|---|---|---|---|---|---|---|
| | *a** | *b*** | *a* | *b* | *a* | *b* | *a* | *b* |
| Controls (micromol./100 gm. rat/min.) | 0·13 | 0·22 | 0·24 | 0·15 | 0·19 | 0·13 | 0·18 | 0·24 |
| Ratio 'Pitocin'/controls | 2·4 | 2·1 | 1·0 | 1·0 | 0·9 | 2·1 | 2·1 | 1·4 |
| Ratio 'Pitressin'/controls | 1·7 | 1·2 | 0·4 | 0·7 | 0·5 | 1·2 | 1·2 | 0·8 |
| Ratio 'Pituitrin'/controls | 2·2 | 1·7 | 1·2 | 1·6 | 1·6 | 3·3 | 1·4 | 0·9 |

*, Rats on standard diet. **, Rats on sodium chloride-enriched diet.

It will be seen from the accompanying table that both 'Pitocin' and 'Pitressin' increased the rate of potassium excretion, but that 'Pitressin' depressed the excretion of sodium. The effects of the posterior pituitary fractions on chloride excretion appeared to depend on the chloride content of the diet. It will also be noted that the effect of 'Pituitrin' on our rats resembled that of 'Pitocin' rather than that of 'Pitressin'. Schaumann[4] used doses more than ten times greater than ours, and it is difficult, therefore, to relate his results to ours, particularly as even the small doses used by us are known to have marked effects on the glomerular filtration-rate in rats (Dicker and Heller[5]). Our experiments are being extended to determine to what extent changes in glomerular filtration-rate produced by the posterior pituitary principles bear on renal electrolyte excretion.

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Sept. 3.

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## Effect of Hæmagglutinating Viruses on the Electrophoretic Mobility of Human Erythrocytes

THE enzymic activity of influenza viruses, recently characterized in chemical terms for the substrate ovomucin[1], was first suggested by Hirst[2], who showed that, following the agglutination of erythrocytes, the virus was eluted spontaneously, leaving the cells inagglutinable by the same strain. Burnet, McCrea and Stone[3] found that cells from which one strain had become eluted were still agglutinable by certain other strains. The arrangement of influenza *A* and *B*, mumps and Newcastle disease viruses in the order of their progressive action on cellular receptors was termed the 'receptor gradient'. Elucidation of this unique enzyme-substrate relationship, characterized by the varying *extent* of interaction, is limited by the qualitative nature of the biological method. The finding of Hanig[4] that, following treatment with the *PR*8 strain of influenza virus, the electrophoretic mobility of human erythrocytes was markedly reduced, suggested a biophysical approach to the problem.

Human cells were incubated at 37° C. with excess amounts of the viruses shown in the accompanying table for periods sufficient to allow the reaction to proceed to completion, as judged by changes in agglutinability and electrophoretic mobility. Except in the case of Newcastle disease and mumps viruses, cells were stabilized with immune serum before testing[3]. Microelectrophoresis was carried out at 25° C. in an $M/15$ phosphate buffer of $p$H 7·35 after the method of Moyer[5].

The results show that with each virus the loss of agglutinability is accompanied by a reduction in mobility, corresponding, in most cases, with the position of the virus in the receptor gradient. New-

castle disease virus, however, reduces the mobility to a value considerably lower than would be expected from the loss in agglutinability. In this connexion, it is of interest that cells treated with Newcastle disease virus previously heated in phosphate buffer show a mobility of 0·90, although the change in agglutinability is similar to that with unheated virus[6]. Though detailed work with swine influenza virus has shown that it lies above *MIL* in the gradient, the reduction in mobility is considerably greater than that obtained with any other virus tested. It is possible that further investigation will yield lower values for *LEE* and *MIL*, as cells treated with these strains have always been agglutinable by the homologous virus. Cells treated with the receptor-destroying enzyme of *V. choleræ* show a very low mobility in accordance with their complete loss of agglutinability. Minor variations in the mobility of different samples of treated cells were usually reflected in similar variations in agglutinability.

| Treatment of cells | Agglutination by standard dose of virus | | | | | | | | Electrophoretic mobility* |
|---|---|---|---|---|---|---|---|---|---|
| | Mumps | *NDV* | *MEL* (*A*) | *PR8* (*A*) | *BEL* (*A*) | *LEE* (*B*) | Swine | *MIL* (*B*) | |
| Mumps | − | + | ++ | ++ | ++ | ++ | ++ | ++ | 1·18 |
| Newcastle disease virus | − | − | − | + | ++ | ++ | ++ | ++ | 0·51 |
| *MEL* (*A*) | − | − | − | + | ++ | ++ | ++ | ++ | 0·78 |
| *PR8* (*A*) | − | − | − | − | + | ++ | ++ | ++ | 0·74 |
| *BEL* (*A*) | − | − | − | − | − | ++ | ++ | ++ | 0·75 |
| *LEE* (*B*) | − | − | − | − | − | ++ | ++ | ++ | 0·74 |
| Swine | − | − | − | − | − | − | − | + | 0·34 |
| *MIL* (*B*) | − | − | − | − | − | − | ++ | ++ | 0·68 |
| Receptor-destroying enzyme of *V. choleræ* | − | − | − | − | − | − | − | − | 0·17 |
| Nil | ++ | ++ | ++ | ++ | ++ | ++ | ++ | ++ | 1·30 |

(*A*), (*B*) = influenza virus type *A*, *B*. * Expressed in μsec./volt/cm. Values given are the averages of several samples.

The biological gradient was further studied by determining the additive effects of successive treatments with different viruses or of one virus followed by the receptor-destroying enzyme of *V. choleræ*. The loss of agglutinability and, with the exception of experiments involving Newcastle disease virus, the change in mobility, was the same after the double treatment as after exposure to the second agent only. The action of a second virus following Newcastle disease virus resulted in a lower mobility value than was given by the second virus itself. Additional experiments with Newcastle disease virus, carried out in collaboration with Prof. F. M. Burnet, have indicated that the reaction of this virus with erythrocytes is more complex than that of the other viruses tested.

It is evident that the receptor gradient can now be expressed in quantitative terms, and it is hoped that this will lead to a fuller understanding of the phenomenon. That agglutinability is not a function of the total residual charge of the cell, however, is exemplified by the relatively slight loss of agglutinability of cells treated with Newcastle disease virus, despite their low mobility.

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## Yellow Pigments of the *Aspergillus niger* Group

The formation of yellow pigments by the *A. niger* group has been frequently reported. Frey[1] reported two pigments: brown aspergillin and a golden-yellow pigment. Roussy[2,3] reported the production of yellow pigments by this group in fatty media; but Pontillon[4] showed that the pigment production was due to the removal of essential salts during the preparation of the medium. Lavollay and Laborey[5–7] showed that growth on magnesium-deficient media produced riboflavin; Giordani[8] had shown earlier that the yellow alkaline extract of *A. niger* spores had an adsorption spectrum similar to that of flavins, and Kitavin[9,10] observed the formation of riboflavin on media containing small amounts of mercuric chloride. In a detailed study of forty-four strains, Knobloch and Sellman[11] found twenty-two which produced yellow pigments; of these, twenty only produced pigments in the presence of reasonable quantities of magnesium, and another produced pigment with magnesium acetate as carbon source.

In an examination of some strains in this Department, some produced small amounts of pigment, both in the presence and also the absence of magnesium. Five other non-pigmented strains showed no formation of pigment when grown in the presence of sodium azide or mercuric chloride. Of these, three produced yellow pigment, two of them abundantly, when grown in submerged culture in Knobloch and Sellman's medium with 4 per cent magnesium acetate as carbon source. The pigment, which occurred as granules in the mycelial pellets, reached its intensity in three days, after which time it was liberated into the medium.

Apart from minor constituents, two main components could be distinguished by paper chromatography. One could be extracted from the medium by chloroform, and had a pale yellow fluorescence in the ultra-violet, whereas the other was insoluble in chloroform but could be extracted by butyl alcohol and had a deep blue fluorescence in ultra-violet light. Knobloch and Sellman refer to the pigment produced by their strains as 'flavin type'. The pigments here described had only end absorption with ultra-violet, showed no change of fluorescence with *p*H, were stable to acids and alkalis and were not reduced by titanous chloride or stannous chloride, from which it appears they are not flavins. Microbiological assay of the pigment solution for the presence of riboflavin indicated only traces of this substance.

It appears, therefore, that strains of the *A. niger* group possess different potentialities for pigment production. In the case of disturbance of normal

metabolism by mercury poisoning or magnesium deficiency, the formation of riboflavin may be related to the necessity for increased respiratory catalyst to overcome the interference with normal metabolism.

The case of the other pigments is not yet clear, and it is of interest to determine whether they fulfil a role in respiration, or whether they are related to the brown and black pigments of the normal mycelium and conidia of this group.

The capacity for pigment production under normal conditions also varies. A strain received from Germany as *A. aureus* (Nakazawa) produced only small amounts of yellow pigment. This organism, which is known only from Nakazawa's original isolates, has been renamed *A. fœtidus* n.sp. by Thom and Raper[12] because of its penetrating actinomyces-like odour. The original specific name given by Nakazawa was due to its orange mycelium, which is deep orange in reverse. We have received an authentic culture of *A. fœtidus* n.sp., through the courtesy of Dr. Raper, which shows marked production of yellow pigment on Czapek medium. According to Thom and Raper[12], *A. fœtidus* n.sp. has maintained its characteristic odour and colour for a number of years. The isolate received from Germany retains the characteristic odour; but the colour production is very slight.

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## Uridine Diphosphate Glucose: the Coenzyme of the Galactose–Glucose Phosphate Isomerization

A previous report[1] dealt with the enzymatic conversion of galactose-1-phosphate into glucose-1-phosphate and mentioned that a thermostable factor is necessary for the reaction. This factor has now been obtained practically pure, and for reasons given below will be referred to as uridine diphosphate glucose.

The preparation of uridine diphosphate was effected by extraction of bakers' yeast with one volume of ethanol, followed by fractional precipitation with mercuric acetate, adsorption on charcoal, elution with ethanol and treatment with a cation-exchange resin.

During the last stages of purification, it was observed that the activity ran parallel with a substance showing absorption at 260 mμ. The same parallelism was observed during paper chromatography with 77 per cent ethanol. The absorption spectrum of the substance is identical with that of uridine, and shows the same changes in acid and alkali, and after treatment with bromine. For each uridine calculated from its absorption coefficient[2], the substance contains two phosphates and two nitrogens.

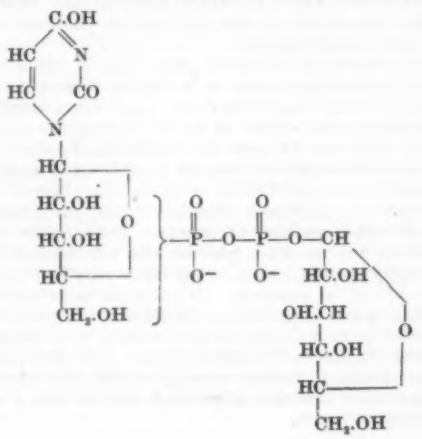
On mild acid hydrolysis, uridine diphosphate loses its coenzymatic activity and yields a molecule of a reducing sugar which was identified as glucose by selective fermentation, paper chromatography, and the carbazole reaction[3] after removing interfering substances with ion exchange resins. The rate of glucose liberation in 0·01 *N* acid at 100° C. is higher than that of glucose-1-phosphate (half-life-time $t_{1/2} = 0{\cdot}8$ and 3·8 min. respectively).

Intact uridine diphosphate is non-reducing, and, together with the liberation of glucose, there occurs a change in the titration curve: it has two primary phosphoric acid groups and no secondary, while removal of the glucose unmasks a secondary acid group. This indicates that the glucose must be combined at position 1 with a phosphate group. Further evidence on the linkage of glucose to phosphate was obtained by treatment of uridine diphosphate with a suspension of washed kidney particles. A substance was liberated which behaved like glucose-1-phosphate under the action of phosphoglucomutase. Oxidation of uridine diphosphate with periodate gave one molecule of formic acid and no formaldehyde, as would be expected from a glucopyranosyl residue.

The substance remaining after removal of the glucose contains two phosphate groups, one of which is 90 per cent hydrolysed in *N* acid at 100° C. in 15 min. After hydrolysing this labile phosphate, the reaction mixture shows two primary and two secondary acid groups. The second phosphate group is very stable, and its rate of hydrolysis was found to be nearly equal to that given by Gulland and Smith[4] for uridine-2-phosphate. However, uridine-5-phosphate cannot as yet be excluded.

The substance remaining after removal of the two phosphate groups was identified as uridine by paper chromatography. The pentose could be estimated by the orcinol reaction after bromination[5]. Further hydrolysis in 6 *N* hydrochloric acid for 2 hr. at 120° C. gave uracil as judged by chromatography and by its spectrum at various *p*H.

On the basis of this evidence, uridine diphosphate can be tentatively assigned the accompanying formula, which shows a pyrophosphate linkage and explains the facts that it has only two primary acid groups, and that one secondary acid group appears on removal of the glucose residue and another on hydrolysis of the labile phosphate. Molecular weight calculated from the dry weight and uridine content gave a value of 630, which is not too far from the theoretical value of 566.



One point is not yet clear; that is the action of alkali. Treatment with 0·1 *N* alkali at 100° C. destroys the activity in a few minutes. No phosphate is liberated; but there occurs a stabilization of the glucosidic linkage so that the glucose now undergoes hydrolysis at the same rate as the first phosphate group. Presumably alkali brings about a rearrangement of the molecule.

The mechanism by which uridine diphosphate accelerates the conversion of galactose into glucose will require further investigation. The fact that glucose phosphate can be recognized as a part of the coenzyme suggests that this portion may exchange with the substrate during the reaction cycle.

An interesting fact is the similarity of uridine diphosphate with the compound which Park and Johnson[6] have found to accumulate in *Staphylococcus aureus* grown in the presence of penicillin. It is not possible from their data to conclude that it is the same compound; but the resemblance is striking.

A full account of this investigation will be published elsewhere.

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## Aphosphorosis in Ireland

Following Colonel Doherty's observation[1] that 'bog crook', a chronic disease of cattle which has been indigenous in certain districts of Ireland for many generations, was clinically similar to stywesiekte, Sheehy[2], in a series of controlled feeding experiments, showed that the feeding of phosphatic supplements was effective in the cure of this condition and concluded that it was aphosphorosis.

Several hundred determinations of blood inorganic phosphorus and of serum phosphatase have been carried out in this Laboratory on samples both from clinical cases of 'bog crook' and from apparently normal animals grazing on the same farms. Analyses of the herbage from the appropriate pastures have also been undertaken.

The results of this work show that a sub-clinical or incipient form as well as a clinical form of aphosphorosis exists, and that both forms are widespread in districts where there is a low phosphorus content in the pasture. In both the clinical and sub-clinical forms of this condition, there is a low level of inorganic phosphorus in the blood; only in the clinical form is there a significant rise in serum phosphatase. On phosphorus-deficient pastures both forms often co-exist, but on such pasture the sub-clinical form is always present and in many cases may be detected only by blood analysis. Sub-clinical aphosphorosis is often associated with unthriftiness, low milk-yield in dairy cows and anœstrus or œstrus with repeated failures to conceive after service. Of the clinical cases, first-calf heifers usually exhibit the severest symptoms. Mature cows and calves are not so seriously affected.

Experiments show that a change of cattle from phosphorus-deficient to phosphorus-sufficient pasture is attended by a more spectacular rise in blood inorganic phosphorus than takes place if the animals are maintained on phosphorus-deficient pasture and fed a phosphatic supplement.

It has been found that where the blood inorganic phosphorus values of members of a grazing herd are of the order of 1·0–2·0 mgm. per cent the pasture herbage contains less than 0·35 per cent $P_2O_5$ dry matter. Provided that cattle are not receiving supplementary feeding in addition to pasture grass, the simplest method of establishing phosphorus-deficiency in pasture is by blood analyses of the cattle grazing thereon.

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## Copper-Deficiency Disease of Pear Trees

Copper has long been considered as one of the essential trace elements connected with satisfactory growth and development of most higher plants[1], and copper-deficiency in various top fruits has been established by workers in the United States, Australia, New Zealand and South Africa. The affected trees show varying amounts of leaf chlorosis, followed by the death of the terminal bud and the dieback of the vigorously growing shoots.

In September 1948, during the course of my duties as an advisory officer, my attention was directed to a very severe case of dieback of terminal shoots in vigorously growing young nursery pears. The trouble was immediately suspected to be copper deficiency, as the symptoms so closely resembled the description of the disease by workers in other countries[2–6].

During the winter season all the dead wood was pruned to induce new growth the following season. In May 1949, when the trees had made some shoot growth, and before any dieback appeared, twelve trees were sprayed with 0·1 per cent copper sulphate solution. The treated trees, by the end of August, made more than 3 ft. of healthy new wood and showed no symptoms of the disease, while the untreated trees made very slow growth and developed severe dieback in early August. The copper content of the leaves from the untreated trees was less than half that of the treated trees.

I believe this to be the first case of copper deficiency of fruit trees and its control by copper sulphate spray recorded in the British Isles. Other troubles peculiar to this nursery are suspected of being connected with the same deficiency, and work is in hand on these problems.

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## Occurrence of Trombiculid Mites on Arthropods

MITES of the family Trombiculidæ include the European harvest-mites and many other notorious scrub-itch mites, as well as the vector of scrub typhus. A closely related group, the Leeuwenhoekiidæ, has also been given familial status[1], both these families having been split off from the Trombidiidæ. Trombidiid and leeuwenhoekiid adults are superficially alike; but adult trombiculids are easily distinguished by being constricted to a figure of eight. The nymphal and adult stages of all three groups are non-parasitic, so far as is known; but the larvæ collectively appear to be the most numerous of all acarine ectoparasites in the tropics. Larval trombidiids are common parasites of insects, while leeuwenhoekiid larvæ have been found parasitizing mammals, birds, reptiles, amphibia, and, more recently, arthropods[2]. That the trombiculid larvæ ('chiggers') parasitize only vertebrate hosts is, however, generally accepted as part of the definition of that family[3]. The following records of three species of trombiculids parasitizing arthropods in Malaya are therefore of considerable interest, and it is hoped that this note may stimulate more attention to this unexpected source.

*Trombicula rara* Walch. A few specimens of *T. rara* have been recorded: on man in Sumatra[4], possibly once in Batavia[5], and on a lizard and on man in New Guinea[6]. It has appeared occasionally on rats in recent collections in Malaya, but its principal host here appears to be a giant forest pill-millipede, provisionally identified as *Zephronia* sp. Large numbers of larvæ may be found attached in colonies to the soft integument near the anus, in a well-protected pocket. About a third of all pill-millipedes from two forest reserves near Kuala Lumpur have been found infested, occasionally with fifty to one hundred larvæ of *T. rara*. A number of nymphs have been bred by Mr. K. L. Cockings from larvæ which have fed on millipedes. An interesting point is that the specimens of *T. rara* from rats and man have been dark red, but those from the millipedes are pale ochre or yellowish in colour.

*Euschöngastia* [*Ascoschöngastia*] species. A single specimen of another chigger, *Euschöngastia* sp. near *E. indica* (Hirst), has also been found, together with a few *T. rara*, on this millipede.

*Trombicula* (or ? *Tragardhula*) sp. indet. A number of specimens of an undescribed *Trombicula* with a pentagonal scutum have been found on the common giant black Malayan scorpion, *Heterometrus longimanus* (Herbst), mostly attached under the pectens. A number of nymphs have been bred from these larvæ by Mr. Cockings. This scorpion is commonly parasitized by a few individuals of a leeuwenhoekiid, *Womersleyia* sp., while several other leeuwenhoekiid larvæ of undetermined genus have been found on a psocid, a ceratopogonid, and on two lamellicorn beetles.

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## Records of the Globefish and Filefish

IN view of the paucity of records of the globefish, *Lagocephalus lagocephalus* (L.), around British coasts, it seems worth while recording the recent occurrence of a specimen at Tenby, Pembrokeshire. According to information supplied by Mr. A. L. Leach, it was found alive on September 6 in a pool on the South Sands, Tenby; its length from snout to fork of caudal fin is 14½ in. The colours of the dead specimen are as described by Day in "The Fishes of Great Britain and Ireland", but Mr. Leach states that the skin of the expansible ventral surface of the living fish appeared distinctly pinkish. Of the thirteen or fourteen British specimens of this tropical species listed by Day, nearly all were taken on the south coast; though there is one Welsh record from Amroth near Tenby, and two records from the Orkneys.

The first British example recorded—from Penzance—was described by the Welsh zoologist Thomas Pennant, who may have been responsible for the Welsh name (very appropriate to the fish when in the round, distended condition) quoted by Day—*Heulbysg crothog*, or swollen sunfish. The Tenby specimen, presented by Messrs. Lillycrop of Tenby, is now in the Zoology Department of the National Museum of Wales, its accession number being 49.373.

This seems a suitable occasion to put on record another plectognath fish very rare in British waters, *Balistes capriscus* Gmelin, the filefish or triggerfish, a specimen of which, 13¼ in. in length, was caught in a net on the foreshore at Splott, Cardiff, on October 26, 1946, and presented to the National Museum of Wales by Mr. F. Newman (accession number 45.352).

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## Seismic Experiments in the Atlantic

EXPERIMENTS were carried out during August 1949 by this Department to determine, primarily, whether a method of seismic refraction shooting at sea developed during the last three years was applicable to deep water. Facilities were provided by the Air Ministry for this work to be undertaken in the Ocean Weather Ship *Weather Explorer* on one of her routine voyages. The area in which the work was undertaken lay within thirty miles of the meteorological position at lat. 53° 50′ N., long. 18° 40′ W., and in this area the depth of water was approximately 1,300 fathoms.

Depth-charges, set to fire at 900 ft. deep, were used as sources of the shock waves. These waves were detected by quartz hydrophones suspended approximately 150 ft. below sono-radio buoys which transmitted the information to the recording instruments in the ship. The charges were fired at distances up to twenty miles from the buoys, four of which were in use simultaneously spread over a line approximately three miles long.

Preliminary calculation of results from these experiments showed the presence of two interfaces below the sea-bed at depths of 7,700 ft. and 16,800 ft. In the surface layer of the bottom three determinations of the velocity of the compressional waves gave

values, at different places within the area, of 6,900, 6,400 and 7,300 ft./sec., with no evidence for a continuous increase of velocity with depth. The intermediate layer showed velocities of 16,300 and 17,300 ft./sec., while the third type of rock, which extended to an indeterminate depth, gave velocities of 21,700 and 20,600 ft./sec. in two different positions. Although the velocities in a given layer showed a considerable scatter, the individual determinations had probable errors not greater than ± 3 per cent.

The low values for the velocity in the surface-layer indicate not highly consolidated marine sediments. Any estimate of the time taken for the deposition of this thickness of sediment is highly speculative and liable to be very misleading. If, however, the sediments are assumed to be of oceanic origin, and if also it is assumed that the sedimentation-rate has, throughout geological time, persisted unchanged at the present order of magnitude, then the time taken for the deposition of a thickness of 7,700 ft. is of the order of 2,000 million years.

The velocity in the layer below the sediments is such as is assigned by seismologists to the granitic layer, but it might equally represent early Palæozoic sedimentary rocks. The depth below sea-level of this layer is approximately the same as that of the continental granitic layer, but its thickness, 9,100 ft., is considerably less.

The two observations of the velocity in the third type of rock are close to the value assigned to the intermediate layer lying between the granitic and ultrabasic layers as determined from near earthquakes.

The experiments also included seismic reflexion shooting with 1¼ lb. T.N.T. charges as the source of energy. These charges were fired a few feet below the surface of the sea, and the low-frequency reflexions from the bottom were received on a hydrophone hung below the ship. The sub-bottom echoes were confused, any one record showing several apparent reflexions which, in general, were unrepeatable. There was, however, one persistent reflexion from a horizon at a depth of about 2,000 ft. below the sea-bed. This horizon does not necessarily represent a discontinuity in velocity, and this may account for the fact that it was not observed in the refraction shooting.

In the reflexion shooting the echo-time obtained from the sea-bed was consistently less than that obtained using the 14 kc./s. echo sounder. The magnitude of the difference was equivalent to 15–20 fathoms of water, and cannot be attributed to instrumental errors. Reflexions are observed where the product of velocity and density changes substantially within one wave-length, and it is therefore possible, assuming only a gradual consolidation, that the strongest reflexions could be produced at depths in the surface layer which increase with frequency.

The echo sounder records frequently showed fluctuating and at times intense echoes from depths between 10 fathoms and 40 fathoms. The discontinuity producing these shallow reflexions was often sufficiently sharp to show up the vertical motion of the ship. Measurements showed no temperature discontinuity at the reflexion depth.

The valuable assistance of Commander H. R. Wilkinson, R.N.R., and his crew in the *Weather Explorer*, to whom the success of the expedition is to a large extent attributable, is gratefully acknowledged. We also wish to acknowledge the assistance from the Air Ministry, the provision of explosives by the Admiralty, and the financial help of the Department of Scientific and Industrial Research.

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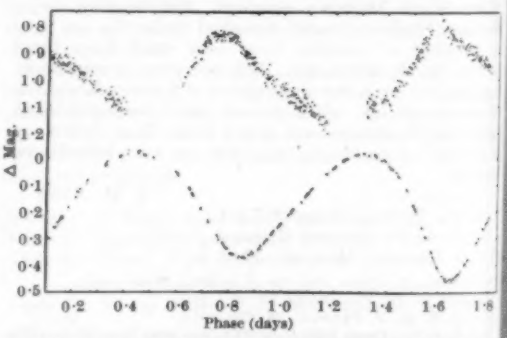
## He II Emission in the Wolf-Rayet Binary Star, CQ Cephei

The origin of the emission lines in Wolf–Rayet stars is not entirely understood. There is supporting evidence that the emission arises in either an envelope large relative to the central star or in an envelope compactly surrounding the central star. It is obvious that if a light curve of an eclipsing binary in which one component were a Wolf–Rayet star could be obtained from a single emission line, one would have valuable data regarding the position of the emitting atoms. For if the emitting atoms were in an envelope large relative to the central star, there would be little change in the intensity of the emission as the Wolf–Rayet star was eclipsed by its companion. If the emission originated in an envelope close to the parent star, then an eclipse of the emission would be expected. An attempt was made to observe the light curve of *CQ* Cephei in He II 4686 photographically during September 1947. However, the results were not conclusive, although it was suspected from visual inspection of earlier spectrograms that the emission was not constant[1].

In September 1949 an attempt was made to obtain the light curve of He II 4686 by photo-electric means. A photo-multiplier was attached to the Cassegrain spectrograph of the 82-inch reflector of the McDonald Observatory, which served as a low-resolution monochromator. The emission line He II 4686 plus 70 A. of continuum was compared to 70 A. of continuum to the red of the emission line. The intensity of the emission line corresponded to a star of magnitude 14·5.

The resulting observations not only confirmed the suspected variation but also in addition gave a light curve of moderate precision. It was found that the intensity of the emission line He II 4686 undergoes a continuous variation. The light curve shows two maxima and two minima. When either star is eclipsed the emission is strongest; it is slightly brighter when the Wolf–Rayet star is eclipsed. At either elongation the emission is weakest[2]; the faintest emission occurs when the Wolf–Rayet component is receding from




Light curves of CQ Cephei. The upper curve was obtained in radiation of He II 4686 only; the lower curve is from integrated light with an effective wave-length of approximately λ 5300. The deeper minimum of the integrated curve corresponds to that phase when the Wolf–Rayet component is eclipsed

the observer. The total amplitude of the light curve is 0·4 mag. The explanation for this observed behaviour of the emission is not known; but investigation of this character on this star and other Wolf–Rayet binaries may well lead to a better understanding of Wolf–Rayet stars.

No departures from the mean curve greater than 0·02 mag. were found except on the night of October 5, 1949, when the emission was 0·15 mag. too bright.

The period of *CQ* Cephei is 1·64 days.

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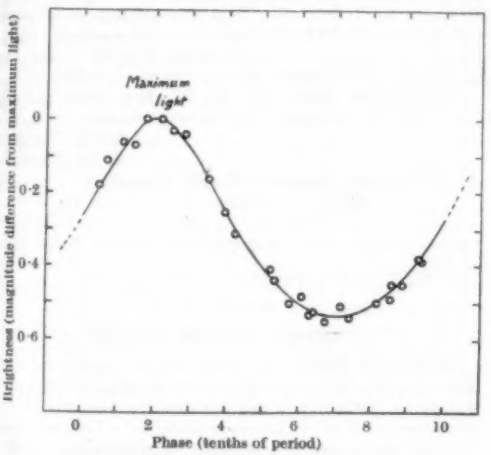
## A Light Curve for the Magnetic Variable Star *HD*125248

The $A_0$ star *HD*125248 (*BD* − 18°3789 Virginis) exhibits periodic changes[1] in the intensities of its absorption lines, principally those due to europium II and chromium II, with a period[2] of 9·295 days; the Eu II lines have their maximum intensity when the Cr II lines are a minimum and vice versa. Babcock[3] finds that this star has a magnetic field which varies with the same period as the absorption lines, the polar field-strength being between 7,000 to 8,000 gauss towards the earth when the Eu II lines have their greatest intensity, and of the order of 6,000 gauss of opposite polarity at the Eu II minimum. The light curve of this star was not hitherto known but has been determined at the Commonwealth Observatory in view of the remarkable interest of this star in connexion with the current theory of magnetism of rotating bodies. The results obtained with the 9-inch Oddie refractor and an *IP*21 electron multiplier are shown in the accompanying graph. The light curve is well defined, the range of the variability being 0·054 mag. with the above period.




Further details will appear later.

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Nov. 28.

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[2] Deutsch, A. J., *Astrophys. J.*, **105**, 283 (1947).
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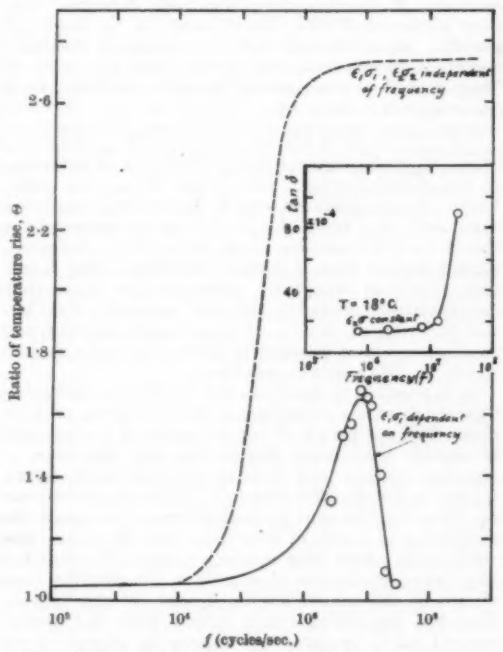
## Frequency-Selective Heating at Radio Frequencies

The differential heating of the components of a heterogeneous mixture by radio-frequency fields is a well-known fact[1,2], and the variation of the effect with frequency is often regarded as an important principle in various applications of radio- and micro-waves, for example, short-wave therapy and radio-heating. The following observations seem to establish, for the first time it is believed, the existence of a peak in the curve showing differential heating over a band of radio-frequencies.

We put a small bulb filled with water into a bath of transformer oil and kept the whole in a high-frequency field. The rises in temperature of oil and water, $\Delta t_1$ and $\Delta t_2$, were recorded constantly, and the ratio $\Delta t_2/\Delta t_1 = \Theta$ was taken after it became constant. When we plot $\Theta$ against frequency $f$, we find a sharp maximum, showing that water in the bulb has undergone a maximum heating at this frequency. (The experimental values are shown as small circles in the accompanying figure.)




$\Delta t_2$ = rise in temp. of water; $\Delta t_1$ = rise in temp. of oil; $\Theta = \Delta t_2/\Delta t_1$. O—O—, observed; ——— and – – – –, calculated

If we denote the amounts of energy absorbed by oil and water by $P_1$ and $P_2$ respectively, it is readily shown that

$$\frac{P_2}{P_1} = \frac{1}{1+\omega^2T^2}\,\frac{9\sigma_1\sigma_2}{(2\sigma_1+\sigma_2)^2} + \frac{\omega^2T^2}{1+\omega^2T^2}\left(\frac{3\varepsilon_1}{2\varepsilon_1+\varepsilon_2}\right)^2\frac{\sigma_2}{\sigma_1}$$

$$\text{where } T = \frac{2\varepsilon_1+\varepsilon_2}{4\pi(2\sigma_1+\sigma_2)} \text{ and } R_2 \ll R_1.$$

Inserting the observed values of the dielectric constants $\varepsilon_1$, $\varepsilon_2$, and the conductivities $\sigma_1$, $\sigma_2$ of the oil and water into this equation, we calculated $P_2/P_1$ for a wide range of frequency, and then by the use of thermal data we estimated $\Theta$ from it. The resulting

curve (full line) shows a close agreement with observed values. The maximum in the curve is associated with anomalous dispersion[3] of the oil, which begins at 13 Mc./s., as is shown by the curve of tan $\delta$ inserted in the main graph. If there is no dispersion, as in the case of liquid paraffin, the resulting curve will be like the broken line, which exhibits saturation character.

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Feb. 4, 1949.

[1] Schliephake, "Kurzwellentherapie" (Jena, 1932).
[2] Pätzold, *Z. für H. F. T.*, **36**, 85 (1933).
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## Thermal Neutron Distribution in a Slab of Paraffin

In a recent note[1] on the tolerance flux of thermal neutrons, P. Capron and others have described how they determined the distribution in a block of paraffin when thermal neutrons from a radium–beryllium howitzer source fall upon the free surface. They find that the neutron distribution function is given approximately by

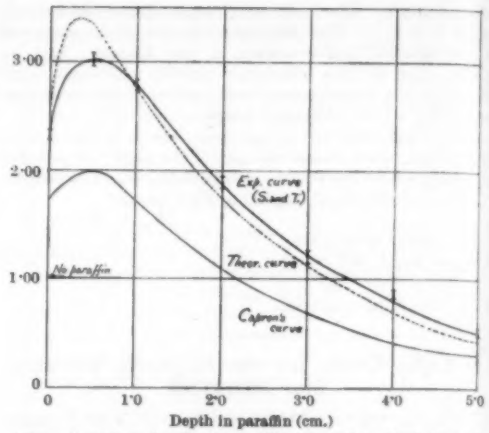
$$N = N_0 \{2{\cdot}55 \exp(-x/L) - \exp(-x/l)\},$$

where $N_0$ is the value of the incident flux of neutrons, $L$ the diffusion-length and $l$ the mean free path. Using this distribution curve, they then calculated the dose in soft tissue due to the $\gamma$-rays emitted from the H $(n, \gamma)$ D reaction, in order to obtain the maximum tolerance flux of thermal neutrons. They found that the dose was three times greater than that calculated by Mitchell[2], who had assumed a distribution function $N_0 \exp(-x/L)$, and suggested that the maximum flux of incident neutrons should be limited to about 500 neutrons/cm.$^2$/sec.

It is possible to calculate the neutron distribution directly from the Boltzmann equation for the neutron flux. The scattering of the neutrons in the paraffin is slightly anisotropic, due to the fact that even at thermal energies the protons are not quite rigidly bound to the paraffin molecule. This anisotropy can be taken into account by taking a model in which the scattering is assumed isotropic, but the mean free path taken longer than it is in practice. The distribution curve which one then gets in the paraffin is as shown in the accompanying figure. It can be seen that the theoretical curve differs from the experimental curve as given by Capron by about 50 per cent.

For this reason the experiment was repeated using a source of thermal neutrons from a pile. This simplifies the experiment from several aspects. As the neutron flux from the pile is far greater than that from the radium–beryllium source, one can use thinner detectors in the paraffin. Detectors made of manganese foil 1 cm.$^2$ in area and 5 'thousandths' thick, mounted on aluminium, were used in this experiment. Also one does not need to correct for epithermal neutrons which are present when the source consists of neutrons slowed down by paraffin. The experimental curve, as indicated in the graph, agrees with the theoretical.

The difference between this and the curve given by Capron is, in all probability, due to the fact that




Thermal neutron density in paraffin for unit incident flux of neutrons. In the calculation of the theoretical curve, the values of $L$ and $\sigma_a$ (hydrogen) were taken as 2·1 cm. and 0·31 barn respectively

the detectors used by Capron were rather thick; and also there is a faulty normalization in their calculation of the incoming neutron flux. The coefficient accompanying the diffusion term in their formula for $N$ should be about 4·5 rather than 2·55.

This would indicate that if one is to retain Mitchell's safety factor of 5, the tolerance flux of thermal neutrons should be divided by a factor 5 and not 3, as suggested by Capron, giving a tolerance flux of 300 neutrons/cm.$^2$/sec.

However, in view of the fact that the thermal distribution in paraffin is now known quite accurately, and that in soft tissue is approximately the same, it would seem that there is no need for a safety factor so high as 5. Neglecting the safety factor entirely, a tolerance flux of about 1,250/cm.$^2$/sec. for neutrons entering normally to the body, as suggested by Mitchell, could be used. This is assuming, as Mitchell did, a value of 10 for the relative biological efficiency factor for protons, and a value of 0·05 r. for the maximum permissible dose of $\gamma$-rays in 8 hours.

We wish to thank Mr. P. W. Mummery for his assistance in carrying out the experiment.

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Aug. 25.

[1] *Nature*, **163**, 129 (1949); *Bull. Acad. Roy. Belgique, Cl. Sci.* (Dec. 1948).
[2] Mitchell, *Brit. J. Rad.* (Feb. 1947).

## Structure of Silk Fibroin

When silk fibroin is dissolved in cupri-ethylenediamine and the solution neutralized and dialysed through a 'Cellophane' sac against running water, an aqueous solution of fibroin is obtained. Coleman and Howitt[1] have suggested that, in this water-soluble state, fibroin can exist in two forms, since at $p$H approximately 3·0, part is precipitated while part remains in solution. They postulated that the former part represents denatured protein in which the molecules of fibroin have an extended chain configuration, whereas that remaining in solution is in a 'renatured' form, with the molecules folded around 'proline hinges'.

By means of partition chromatography on filter paper[2], we have established the chemical identity of these denatured and renatured forms, and have also shown that both, in their turn, have an amino-acid composition identical with fibroin itself. Hydrochloric acid hydrolysates of the two fibroin fractions and of whole fibroin (degummed silk fibre) all gave identical chromatograms with regard to position, as well as size and intensity, of the amino-acid spots. The following amino-acids were shown to be present in all three: aspartic acid, glutamic acid, serine, threonine, glycine, alanine, valine, leucine, phenylalanine, tyrosine, arginine and proline.

The identity of these three forms of fibroin is demanded by the hypothesis, since the process which changes a native protein into its denatured form involves nothing more than a physical rearrangement of the molecules.

The disposition within the molecule of the constituent amino-acids of the renatured form was investigated by means of a short-duration tryptic hydrolysis of a solution of renatured fibroin. After 30 minutes of such hydrolysis, the precipitate which had formed was removed. Chromatography showed that this precipitate consisted of glycine, alanine and serine.

The chromatogram of the hydrolysis liquor, on the other hand, gave correspondingly strong spots for tyrosine, valine, leucine, arginine, phenylalanine, aspartic and glutamic acids and proline. A chromatogram obtained after hydrolysing a weight of trypsin equal to that used in this experiment showed none of these acids, as the amount of trypsin used is very small in comparison with the weight of fibroin.

Estimations of the molecular weight of the precipitate from viscosity measurements of its solution in cupri-ethylenediamine gave values around 7,000. More accurate determinations of this molecular weight, together with the range of molecular weights about this mean, are at present being attempted using an ultra-centrifuge.

The isolation from fibroin of this polypeptide of molecular weight approximately 7,000 and composed entirely of the three simplest amino-acids, glycine, alanine and serine, is of importance in the elucidation of the structure of the protein. It is now possible to construct a reasonably complete picture of the folded molecule of renatured fibroin. Between the three regions, of total residue-weight 7,000 each, lie two regions containing all those amino-acids with bulky side-chains. Using results from the most recent amino-acid analyses of fibroin, it is possible to calculate that the weight of these bulky amino-acids (together with part of the serine) per molecule totals about 10,000. Thus in the fibroin molecule of molecular weight 33,000 [1], three straight-chain sections can be envisaged with a total residue weight of 7,000 each, and containing only glycine, alanine and serine, linked by two regions of total residue weight 5,000 each and containing all the bulky amino-acids of the molecule.

These results are comparable with the X-ray results on fibroin obtained by Meyer, Fuld and Klemm[3], who showed that fibroin gave an X-ray photograph which indicated a crystalline peptide chain consisting only of glycine alternating with alanine (or serine). Coupling of the tyrosine with diazobenzenesulphonic acid left the X-ray diagram unchanged, showing that this amino-acid is in the amorphous region.

A detailed account of this work will be published elsewhere in the near future.

We wish to acknowledge the helpful discussions we have had with Dr. F. O. Howitt during the course of this work, and also the assistance of Mr. Trevor Hamlin in much of the experimental work.

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Sept. 12.

[1] Coleman, D., and Howitt, F. O., *Proc. Roy. Soc.*, A, **190**, 145 (1949).
[2] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).
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## A Relay Machine for the Demonstration of Symbolic Logic

Eighty years ago, Jevons, then professor of logic at Owens College (now the University of Manchester), built a machine which could perform logical inference by mechanical means[1]. Other similar machines have been built since then. With the present interest in electrical and electronic computing machines, it seemed worth while to construct a logical machine using modern electrical methods, at the same time basing it on the present-day logical technique of truth tables rather more explicitly than had been done by Jevons.

A small machine incorporating these ideas has now been built at the Instrument Department of Ferranti, Ltd. The machine deals with the logical relations between three propositions or 'variables' $A$, $B$, $C$. These variables and their 'functions' (relations) are represented in the form of binary numbers (essentially an abbreviated form of their Boolean expansions) which are stored in electromagnetic relays, 'on' (1) standing for truth, 'off' (0) for falsehood. The state of each relay is indicated by a lamp.

Five stores, each containing eight relays, are provided. Two of these ($U$, $V$) accept the initial propositions $A$, $B$, $C$ and their negatives. A third store $S$ accepts the result of a logical operation performed on the contents of $U$ and $V$; these operations, which can be selected by corresponding switches, are conjunction ('and'), disjunction ('or'), implication ('if, then'), equivalence ('if and only if') and negation ('not').

The contents of $S$ can be transferred to two auxiliary stores and from there back to $U$ and $V$ so that further operations can be performed on them.

A tautological relation is indicated by the lighting up of all the eight lamps of store $S$.

A function $F(A, B, C)$ implies, in general, a number of functions $R(A, B)$ of two variables. It is then pertinent to ask for that particular function $G(A, B)$ among them, which implies all the others. This 'optimum implicate' can be found by a process closely analogous to the projection of a three-dimensional pattern on a two-dimensional plane. Facilities for carrying out this process are provided in the machine.

It is not to be expected that a machine of this small size will be able to solve logical problems which could not be done with pencil and paper, but it is

hoped that this machine may prove to be of value in the teaching of symbolic logic, and that it will stimulate the interest of students in what otherwise tends to become a rather dull subject, and impress on them the mechanical nature of logical operations.

Acknowledgments are due to Ferranti, Ltd., for providing facilities for the construction of the machine and to Mr. R. Naylor for his work in assembling it. A fuller description of the machine and the underlying logical methods will be published elsewhere.

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[1] Jevons, W. Stanley, *Phil. Trans. Roy. Soc.* **160**, 497 (1870).

## Wetting and Contact-Angle Hysteresis

The study of contact angles and contact-angle hysteresis in the region of low contact angles is not easy owing to difficulties of technique. The contact angle, $\theta$, is given by

$$\cos\theta = \frac{\gamma_{SA} - \gamma_{SL}}{\gamma_{LA}}, \qquad (1)$$

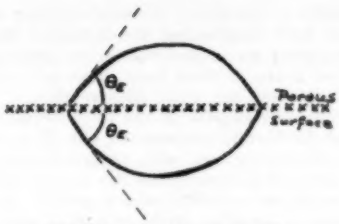
where $\theta$ is the contact angle measured in the liquid and $\gamma_{SA}$, $\gamma_{SL}$ and $\gamma_{LA}$ are the surface free energies per unit area of the solid–air, solid–liquid and liquid–air interfaces respectively.

In any practical case using a pure liquid, $\gamma_{SA}$ is not the true value, as the solid surface is modified by adsorption of the vapour of the liquid; and so in any contact-angle measurements it is the effective or modified value of $\gamma_{SA}$ which is of importance[1–3]. If a wetting agent is used, then all the interfacial energies may be modified by adsorption of the wetting agent. The interfacial energies considered in equation (1), therefore, will be the effective values. In general, equation (1) may be written:

$$\gamma_{SA} - \gamma_{SL} = k\gamma_{LA}, \qquad (2)$$

and wetting of a solid by a liquid is considered to occur when $k \geqslant 1$ [4,5]. The direct measurement of $k$ for such values is not possible as no finite contact angle exists.

Measurements of $k$ can, however, be made using an extension of the theory of the water repellency of porous surfaces[6]. If we consider a porous surface, then any liquid with a positive value of $k$ will penetrate to some degree into the surface. If we have a thin porous surface, then a drop of liquid with $k \geqslant 1$ will penetrate through the surface and, provided the porosity is sufficiently high and the drop sufficiently small, it will orient itself symmetrically on both sides of the surface, as is shown diagrammatically in the figure. In such a position the drop is completely stable and no spreading occurs along the solid portions of the porous surface even if they are continuous. That no spreading occurs along a fine filament in contact with a drop large in comparison with the filament diameter can readily be shown by suspending a drop of, say, liquid paraffin on a glass filament, when it will remain indefinitely if evaporation is eliminated. Spreading of a spherical drop over a cylindrical surface can only take place when the cylinder radius is greater than half the radius of




Liquid drop on thin porous surface

the drop, even though $k$ is equal to unity. The contact angle, $\theta_E$, of the diagram can be shown to be given by

$$\cos\theta_E = \frac{f}{2}k, \qquad (3)$$

where $f$ is the area of solid–air interface per unit geometrical area of the porous surface. Therefore, as $f$ and $\theta_E$ can be measured, $k$ can be determined.

In no case was a value of $k > 1$ found and, using such liquids as benzene, aniline, diethyl phthalate, on fine nickel and copper structures[7], the values of $\theta_E$ were found to be identical for all the organic liquids tested and were the same for expanding and contracting drops. Further, a determination of $f$ showed that $k$ was unity in all these cases. It was interesting to note that when a wetting agent was added to water, the maximum value of $k$ was again unity, and in this case also no contact-angle hysteresis was observable.

These results indicate that the liquid in such cases is, in fact, spreading over an adsorbed layer of itself on the solid, and that the energy changes on spreading are zero or negligible. That no hysteresis occurs indicates complete coverage of the solid surface by a layer of adsorbed molecules of the liquid. This is, of course, to be expected, since if the true value of $k$ is greater than 1, then the liquid would have more affinity for the solid than for itself. In such a case complete coverage would take place.

A fuller account of this work, together with its application to the study of surface-active agents in wetting and detergency, will be presented in due course.

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[1] Bangham and Razouk, *Trans. Farad. Soc.*, **33**, 1459 (1937).
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## Induced Molecular Vibrational and Rotational Absorption

In view of recent advances in the technique of absorption measurements in the infra-red and micro-wave regions, I wish to direct attention to a method by which transitions normally forbidden in such absorption might be made to appear. The method is applicable, for example, to the vibration and rotation of homonuclear diatomic molecules and to the breathing mode of vibration of molecules like

$CH_4$; and, in general, to all transitions that are permitted in the Raman effect.

Consider first vibrational transitions. The appearance of a fundamental vibration frequency in the Raman spectrum is due to a change of polarizability with nuclear vibration co-ordinate. Therefore, if we apply an electrostatic field to the molecule, there must be a change of the induced electric dipole moment during the vibration in question. The condition for the appearance of the frequency in infra-red absorption is thus realized. In the induced effect, the quantity $E\alpha'$ (where $E$ is the applied field-strength and $\alpha'$ is the derived polarizability) will play the same part as does $\mu'$ (the rate of change of permanent dipole moment with nuclear co-ordinate) in ordinary dipole absorption. From absorption measurements in the infra-red, the value of $\mu'$ for HCl has been found[1] to be $0{\cdot}086e$ (where $e$ is electronic charge). Recently Herzberg[2] has succeeded in observing the infra-red quadrupole absorption of $H_2$, the strength of which is calculated to be only $8{\cdot}1 \times 10^{-9}$ of that for the dipole absorption of HCl. Considering now the induced effect for the breathing mode of $CH_4$, the value $\alpha' = 7{\cdot}7 \times 10^{-16}$ cm.[3] has been deduced[3] from the isotope effect upon refractivity. Neglecting the small influence of the amplitude factor of the transition moment, we hence calculate that the applied field-strength required to induce for this mode of $CH_4$ an absorption as strong as that observed by Herzberg would be about $2 \times 10^3$ volts/cm. In practice, a value perhaps ten times greater than this might be used without exceeding the dielectric strength of the gas. This would induce an absorption a hundred times stronger. It appears that the induced effect should be well within the limits of observation.

It is of importance to note that the applied field could be given a definite periodicity, so that the induced effect would be modulated and high sensitivity of detection could be achieved by the use of selective amplification.

In the breathing mode of vibration of $CH_4$, the polarizability remains isotropic and the induced moment independent of molecular orientation. Rotational transitions would thus be forbidden: only the $Q$-branch would be observed. For a non-isotropic molecule like $H_2$, the induced vibrational absorption would (like the Raman effect) be associated with the rotational selection rule $\Delta J = 0, \pm 2$.

Coming now to pure rotational absorption, it would be an important advance if, by the application of the induced absorption effect, the powerful and precise methods of micro-wave spectroscopy could be extended to the study of non-polar molecules. Present technique is reported[4] to permit the detection of an attenuation coefficient of about $10^{-9}$ cm.$^{-1}$. Taking $\nu = 1$ cm.$^{-1}$, $J = 1$, $T = 200$ and the line breadth constant $(\Delta\nu)_1 = 10$ mc., we calculate that the corresponding dipole moment is of the order of $10^{-3}$ $D$. In the induced absorption for a non-polar linear molecule the effective dipole moment may be set roughly equal to $E(A - B)$, where $A$ and $B$ are respectively the polarizabilities along and at right angles to the axis of the molecule. The difference $(A - B)$ can be determined from the refractivity and the degree of depolarization of Rayleigh scattering, and will be of the order of $10^{-24}$ cm.$^3$. Hence we calculate that the applied field-strength required in order to give a strength of induced absorption just detectable with the present sensitivity would be of the order of $10^5$ volts/cm. It is estimated[4] that an attenuation coefficient as low as about $10^{-11}$ cm.$^{-1}$ could be detected with improved technique, in which case the applied field-strength would have to be of the order of $10^4$ volts/cm. It thus appears that with the strongest practicable fields the intensity of the induced pure rotational absorption would probably be near the limits of experimental detection. The induced absorption would, of course, show the Stark effect.

Since preparing this letter, my notice has been directed for the first time to a paper published in 1932 by Condon[5], in which the effect of an applied electrostatic field in inducing vibrational absorption was similarly considered. Despite the notable advances of technique achieved since that date in the infra-red and more especially in the micro-wave region, the possibilities of induced absorption have not (so far as I am aware) been the subject of experimental investigation.

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## Thermo-osmosis of Gases Through a Membrane

Denbigh[1] has recently reported the discovery of a thermo-osmosis phenomenon for carbon dioxide and hydrogen through rubber diaphragms. When a temperature-difference is maintained across the diaphragm, a flow of carbon dioxide occurs from the cold to the warm side until, in the absence of an external circuit, a stationary pressure difference is built up sufficient to prevent further flow. The effect with hydrogen is in the opposite direction and is only about 30 per cent of that with carbon dioxide. The data satisfy the equation:

$$\log \frac{p_1}{p^2} = \frac{Q^*}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right). \qquad (1)$$

Denbigh suggested that the phenomenon might be due to the effect of temperature on the solubility of the gas in the membrane. It is the purpose of this note to show that, indeed, the data can be quantitatively accounted for on this basis alone, the possibility of a thermal diffusion process within the membrane being neglected.

Within the pressure-range studied, the solubility of the gas in rubber follows Henry's law. We may write

$$c = kp, \qquad (2)$$

where $c$ is the concentration of dissolved gas, $p$ the gas pressure, and $k$, the solubility constant, a function of temperature. If the pressures on the two sides of a membrane are maintained equal, the existence of a temperature-difference will, in general, result in different values of $k$, and therefore of $c$, at the two surfaces of the membrane. The difference in values of $c$ constitutes a driving force for the gas, and gas will flow continuously if an external circuit is provided. If there is no external circuit, gas will continue to flow until the values of $c$ on the two sides are equalized. From (2) we have $c_1 = k_1 p_1$ and

$c_2 = k_2 p_2$ for the two sides of the diaphragm. The condition for the establishment of a stationary pressure difference is $c_1 = c_2$. This implies $k_1 p_1 = k_2 p_2$, or

$$\log \frac{p_1}{p_2} = \log \frac{k_2}{k_1}. \quad (3)$$

Now to a good approximation $k$ depends exponentially on temperature:

$$k = k_0 \exp - Q^*/RT, \quad (4)$$

where $Q^*$ is related to the heat of solution. For temperatures $T_1$ and $T_2$,

$$\log \frac{k_2}{k_1} = \frac{Q^*}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right). \quad (5)$$

Substitution of (5) in (3) results in (1), the equation given by Denbigh.

The values of $Q^*$ for carbon dioxide and hydrogen may be obtained from the data of van Amerongen[2] on various rubbers. $Q^*$ for carbon dioxide in natural rubber is about − 2,700 cal./mole, while $Q^*$ for hydrogen is about + 1,000 cal./mole. It should be noted that the signs are in the right direction, carbon dioxide showing a flow from cold to warm and hydrogen from warm to cold, and that the value for hydrogen is only about a third that for carbon dioxide, in agreement with observation. The value of $Q^*$ for carbon dioxide given by Denbigh, − 309 cal./mole, is low, as Denbigh points out, because the temperatures measured were not the true surface temperatures.

If the explanation given is correct, it is clear that every gas the solubility of which in the membrane decreases with increasing temperature will show a thermo-osmotic flow from cold to warm, and conversely for gases the solubilities of which increase with increasing temperature.

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Washington 25, D.C.
July 22.

[1] Denbigh, *Nature*, **163**, 60 (1949).
[2] van Amerongen, *J. App. Phys.*, **17**, 972 (1946).

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The temperature coefficient of solubility is undoubtedly *one* of the components of the thermo-osmosis effect. However, Dr. S. Weller is in error when he says "the data can be quantitatively accounted for on this basis alone . . ." To do this it would have to be shown that the observed values of $Q^*$ are *equal* to the known values of the heats of solution. On the other hand, if thermal diffusion is an appreciable second component, this equality would not be obtained. The testing of these possibilities is the object of our experiments and has not yet been achieved on account of difficulties in measuring the surface temperatures.

The treatment put forward by Dr. Weller was known to us at the time of the original communication and depends on the supposition $c_1 = c_2$, that is, that there is no concentration gradient of dissolved gas. It is only when this occurs that the theory based on equilibrium thermodynamics and Henry's law is approximately correct. In the more general treatment it is necessary to allow for the possibility of a finite thermal diffusion within the membrane. This can be done on the basis of Thomson's hypothesis[1] or by the use of Onsager's theorem. This results in an expression of the same *form* as quoted by Dr. Weller and as given in the original communication. The quantity $Q^*$ is the 'heat of transport' across the membrane and reduces to the heat of solution only in the limiting case of no thermal diffusion[2]. Some preliminary results on nitrogen indicate, however, that the latter effect may be appreciable. This gas passes through the rubber membrane from cold to warm. On the other hand, the temperature coefficient of its solubility is either zero[3], or has a very small positive value[4] which would indicate a flow in the reverse direction to that observed. However, these results are not yet quite certain, as the nitrogen was not of the highest purity.

It may be mentioned that whereas the above is concerned with diffusion normal to an interface, we are now extending observations to the case of thermal diffusion in surface layers on solids in a direction *parallel* to the interface, with possible applications in adsorption, catalysis, sintering, etc.

K. G. Denbigh
Chemical Engineering Laboratory,
Cambridge.

G. Raumann
Butterwick Research Laboratories,
Imperial Chemical Industries, Ltd.,
Welwyn.

[1] Eastman, *J. Amer. Chem. Soc.*, **48**, 1482 (1926).
[2] Wirtz (*Z. Naturforsch.*, **3a**, 380 (1948)) has reached similar conclusions from a kinetic argument.
[3] Barrer and Skirrow, *J. Polymer Sci.*, **3**, 564 (1948).
[4] van Amerongen, *J. App. Phys.*, **17**, 972 (1946).

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## Relativistic Variation of Rest Mass

We propose to show that the constancy of rest mass during non-uniform movement is by no means a general feature of restricted relativity. It applies only to a special, though very important, type of a model, namely, the point charge model.

It is sufficient for our purpose to write the dynamical laws in the form

$$\frac{\partial T_i{}^k}{\partial x_k} = - F_{ik} \cdot s^k, \quad (1)$$

with

$$T_i{}^k = \mu_0 c^2 \cdot u_i \cdot u^k; \quad s^k = \rho_0 \cdot w^k,$$

$F_{ik}$ being the electromagnetic field tensor, $\mu_0$ and $\rho_0$ the rest densities of mass and charge distributions and $u^k$ and $w^k$ the velocity four-vectors of mass and charge convection. Then we obtain from (1):

$$\mu_0 c^2 \cdot \frac{du_i}{ds} + \frac{\partial \mu_0 c^2 u^k}{\partial x_k} u_i = - \rho_0 F_{ik} w^k, \quad (2)$$

$$\frac{\partial \mu_0 c^2 u^k}{\partial x_k} = - \rho_0 F_{ik} u^i \cdot w^k. \quad (3)$$

(3) determines the rest mass balance. In the case of point charges, $u^k = w^k$, (3) becomes a conservation law. In general, however, no conservation of rest mass takes place.

We can immediately apply (2) and (3) to Ampère's experiment (attraction between two parallel currents),

where the direction of force and of current do not coincide. We obtain from (2) and (3) that energy is conserved

$$\frac{d}{dt}\left(\frac{mc^2}{\sqrt{1-u^2/c^2}}\right) = 0; \qquad (4)$$

but both $m$ and $\mathbf{u}$ vary during the motion. Of course, in this case the variation of total mass $m$ can be attributed to the variation of the kinetic energy of internal movements (included in the total mass), for example, to a decrease of kinetic energy of supposed point charges which form the current.

(4) applies equally well, if we consider the interaction between two small circuits (magnetic dipole model) of magnetic moment $M$ and $\mu$. Considering $M$ fixed and $\mu$ moving towards it from rest at infinite distance, we find from (2) and (3):

$$m = m_\infty \sqrt{1 - 2\frac{\mathbf{uH}}{m_\infty c^2}} \cong m_\infty - \frac{\mathbf{uH}}{mc_0^2}. \qquad (5)$$

(5) represents the mass defect of our system due to the orientation of the magnetic moment in the external field. Schwinger[1] has found, in the case of Dirac's electron, which is much closer to the point-charge model, a considerably ($2 \times 137$) smaller value for the mass defect.

Generalizing our results to the case of an arbitrary static field, we find that this field does not contribute directly to the energy of the system by

$$\frac{1}{8\pi}\int (E^2 + H^2) \, . \, d\tau,$$

but indirectly by its contribution to the mass of the system

$$\frac{1}{8\pi}\int (E^2 - H^2) \, . \, d\tau. \qquad (6)$$

At least a part of the mass of a charged particle being distributed according to (6), a charged particle cannot be represented rigorously by a point-charge model. In the mechanical representation

$$p_0 - \frac{\mathbf{v}}{c} \, . \, \mathbf{p} = \sqrt{1 - \frac{v^2}{c^2}} \, . \, mc; \qquad (7)$$

it is the right-hand side which corresponds, partly or entirely, to (6).

The fact that rest mass depends on fields is therefore a general feature of relativistic dynamics. It explains slight mass variations of elementary particles, mass defects of compound systems, and it can lead to an understanding of the much more drastic mass changes which we witness if pairs of electrons are created or annihilated.

GUIDO BECK

Córdoba Observatory.
July 29.

[1] Schwinger, J., *Phys. Rev.*, **73**, 416 (1948).

## Corrosion Resistance of Analytical Weights

THE thinly plated or plain polished brass weights commonly used in laboratories are too frequently unreliable, even under good atmospheric conditions. Weights of 80 per cent nickel – 20 per cent chromium non-magnetic alloy, first suggested by the National Physical Laboratory, though more expensive than plated weights, were known to be very stable in mass under good atmospheric conditions, and have been commercially available for ten years. More recently, following tests made at the National Physical Laboratory on the magnetic properties of various stainless steels[1], the 25 per cent chromium – 20 per cent nickel type has also been recommended, and weights of this material are now available. However, little information has hitherto been available on the stability of weights in the contaminated atmosphere of chemical laboratories, though Ward[2] made high claims for chromium-plated weights, partly on his own experience and partly on the basis of observations by Manley[3] on the removable film formed on weights during storage under good conditions.

The National Physical Laboratory has now completed some comprehensive comparative tests of weights of all these materials, giving special attention to the effect of thickness of plating on the resistance to corrosion of brass weights plated with platinum and rhodium (with and without underlying silver), and chromium (over nickel). With the view of obtaining results quickly, a representative selection of 100-gm. weights was exposed for two three-month periods over the working bench in each of five chemical laboratories, the chemical content of the atmospheres of which varied widely both in quality and quantity. The weights were exposed freely to the atmosphere, but were well shielded from dust.

The main results, judged principally from changes in mass, are:

(1) The most resistant weights were of highly polished 25 per cent chromium – 20 per cent nickel stainless steel.

(2) There was little to choose between weights of less highly polished 25 per cent chromium – 20 per cent nickel stainless steel, 80 per cent nickel – 20 per cent chromium nickel-chromium and plated weights having a nominal thickness of plating of about 0·015 mm. or more. Weights coated with merely a 'flash' of platinum, or rhodium, were not very much superior to weights of plain polished brass, the changes of which were more than ten times those of the best weights.

(3) Among the plated weights, the appearance of those plated with chromium deteriorated the least; but any superiority in the stability in mass of these weights over other weights having the same total thickness of plating was only slight.

(4) The experience of the National Physical Laboratory that some good-quality plated weights show considerable changes in mass, even under good atmospheric conditions, was confirmed. The mechanism of these changes is not yet clear.

(5) No correlation was found between the different chemical characteristics of the individual laboratories and the changes in the particular weights exposed in them.

An account of this investigation is being prepared for publication elsewhere.

P. H. BIGG
F. H. BURCH

National Physical Laboratory,
Teddington, Middlesex.
Nov. 9.

[1] Gould, F. A., *J. Sci. Instr.*, **23**, 124 (1946).
[2] Ward, A. F. H., *Chem. and Indust.*, 393 (1945).
[3] Manley, J. J., *Phil. Mag.*, **16**, (7), 489 (1933).

## Dissociation Constants and Dissociation Velocities of Substituted Pyruvic Acids

It has been shown[1] that weak acids are very often reduced polarographically in two steps. The more positive step belongs to the undissociated acid, the more negative to the acid ion. The total height of these two steps remains constant; but their ratio is changed in a characteristic way with the $p$H of the solution. If we plot this ratio against the $p$H, we obtain a curve which resembles very closely a dissociation curve. The $pK$ of this dissociation curve is, however, generally shifted several $p$H units to higher values in comparison with the true acidity of the particular acid.

This shift is due[1] to the rapid recombination of the acid ions with protons in the neighbourhood of the dropping electrode. The mathematical theory developed[1,2,3] introduced simplifications, but accounted for all the facts. Later a rigorous formulation was given, and it is possible[4] to calculate the velocity constant of the recombination reaction accurately from the shift of the $pK$ value.

In this calculation it was assumed that the recombination is due solely to the reaction between acid ions $Ac'$ and free hydrogen ions. Therefore, for the calculation of the effective velocity constant $k_{ef}$, the simplified form of the reaction velocity expression $k_{ef}\,[Ac']\,[H^+]$ is used instead of the more accurate

$$k_{H^+}\,[Ac']\,[H^+] + k_{H_2O}\,[Ac']\,[H_2O] + k_{acH}\,[Ac']\,[acH$$

that is,

$$k_{ef}[H^+] = k_{H^+}\,[H^+] + k_{H_2O}\,[H_2O] + k_{acH}\,[acH],$$

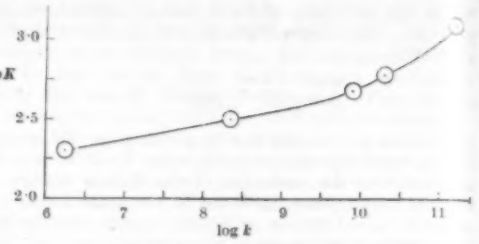
where $ac$H represents the acid of the buffer solution.

We can, however, compare $k_{ef}$ for different acids if we use the same buffer solution. Also changes in buffer concentration have only a very small influence. In view of the importance of the relationship between the dissociation constants and dissociation velocities of acids for the theory of acid-base catalysis and for the interpretation of the Brønsted equation, we have determined the dissociation constants and $k_{ef}$ of a number of substituted pyruvic acids. The results are given in the accompanying table. The buffer solution used was the Britton–Robinson[5] universal buffer.

| Acid | $pK$ | $pK_p$ | $t$ | log $k_{ef}$ |
|---|---|---|---|---|
| 3,4 Dimethoxyphenyl-pyruvic | 3·10 | 7·6 | 2·90 | 11·24 |
| Phenylpyruvic | 2·68 | 6·72 | 2·93 | 9·89 |
| Trimethylpyruvic | 2·30 | 4·70 | 2·90 | 6·24 |
| Pyruvic | 2·50 | 5·85 | 2·97 | 8·33 |
| Diphenylpyruvic | 2·78 | 6·98 | 3·00 | 10·30 |

$t$, drop time of the mercury electrode; $pK$, real $pK$ determined by potentiometric titration; $pK_p$, apparent polarographic dissociation constant which gives the $p$H at which the positive and negative polarographic waves have the same height; log $k_{ef}$ was obtained by the Koutecky and Brdicka calculation, namely, log $k_{ef} = 2(pK_p - \frac{1}{2}\log y_1) - pK - \log t$; $y_1$ is a tabulated function (ref. 4).

Plotting log $k_{ef}$ against $pK$, it is found that the values lie on a smooth curve which is nearly a straight line (see graph). Several acids not belonging to the pyruvic acid series have been found to give $pK$ and $k_{ef}$ values which do not lie on this curve.




We hope to investigate other series of homologues and to eliminate completely the influence of the buffer by systematic variation of buffer concentration and extrapolation to zero.

E. G. Clair
K. Wiesner

Chemistry Department,
University of New Brunswick,
Fredericton, N.B.
Aug. 18.

[1] Brdicka, R., and Wiesner, K., *Coll.*, **12**, 138 (1947); *Chem. listy*, **40**, 66 (1946).
[2] Wiesner, K., *Chem. listy*, **41**, 6 (1947).
[3] Brdicka, R., *Coll.*, **12**, 212 (1947).
[4] Koutecky and Brdicka, *Coll.*, **12**, 338 (1947).
[5] Britton, H. T. S., "Hydrogen Ions", 225 (1932)

## Oxides of Praseodymium

The two oxides of praseodymium described in the literature are the light green sesquioxide and the dark brown 'air-ignited' oxide. It is generally agreed that the composition of the latter approximates to $Pr_6O_{11}$. Prandtl and his school[1] claim that praseodymium can exhibit a higher valency of 5, and on this basis designate the air-ignited oxide as $2Pr_2O_3.Pr_2O_5$. Marsh[2] affirms, however, that praseodymium possesses a maximum valency of 4, a conclusion which is well supported by the work of Zintl and Morawietz[3], and represents $Pr_6O_{11}$ as the double oxide, $4PrO_2.Pr_2O_3$.

Since $Pr_2O_3$ is derived from the lower of the two valence states of praseodymium, it might be expected that the potential quadrivalency (on energetic grounds quadrivalency appears more likely than pentavalency) of this metal will favour the formation of a non-stoichiometric phase with a range of composition on the oxygen-rich side of the ideal formula. According to Wilson's[4] theory of semi-conductors, these oxides would be deficit conductors showing positive-hole conduction. Conversely, $PrO_2$, if partly denuded of oxygen, would give rise to oxides which are on the metal-rich side of the ideal formula and are electron conductors.

The present communication reports experiments which indicate that this is indeed the case, and that praseodymium forms a series of non-stoichiometric oxides in the range $PrO_{1\cdot5} - PrO_{2\cdot0}$. On this basis the air-ignited (that is, ignited in a partial pressure of 150 mm. oxygen) oxide is non-stoichiometric in character and is properly represented by the formula $PrO_{1\cdot82}$. No particular significance should be ascribed to the representation $Pr_6O_{11}$.

Tensiometric measurements on this oxide system, in conjunction with X-ray diffraction patterns of oxides $PrO_{1\cdot500}$, $PrO_{1\cdot555}$, $PrO_{1\cdot650}$, $PrO_{1\cdot710}$ and $PrO_{1\cdot833}$, indicate that two oxide phases exist, one cubic and one hexagonal. The former is derived from

the fluorite type, $PrO_2$, the latter from the hexagonal type *A*, $Pr_2O_3$ [5]. These measurements indicate that the range of stability of the intermediate phases is as shown in the accompanying scheme. The estimated compositions of the phase boundaries are uncertain to about 2 per cent.

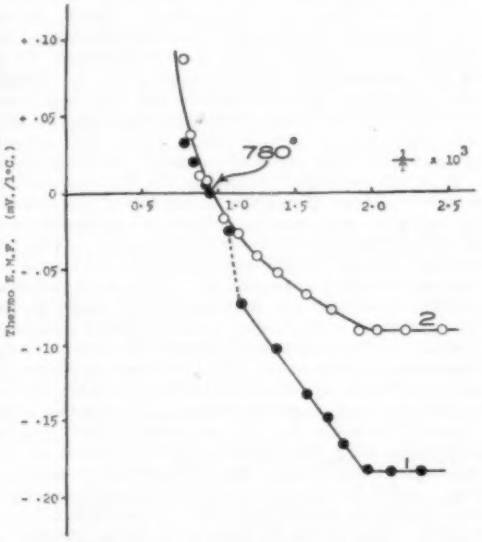
| *Hexagonal* Type *A* plus oxygen | Two-phase region | *Cubic* Fluorite minus oxygen |
|---|---|---|
| $PrO_{1.50}$ | $PrO_{1.88}$ | $PrO_{1.72}$ $PrO_{2.0}$ |

Thermo-electric measurements supported this phase diagram. Thus it was found that oxides with the hexagonal type *A* structure displayed positive thermo-potentials, confirming that type *A* $PrO_{1.50}$ can accommodate small amounts of additional oxygen in the lattice. On the other hand, the air-ignited oxide, $PrO_{1.83}$, exhibited negative thermo-potentials, showing that it is effectively $PrO_2$ deficient in oxygen, and *not* $PrO_{1.80}$ with excess oxygen.

In the course of these measurements, it was found that type *A* oxides exhibited much larger thermo-potentials than the air-ignited oxide. It might be expected, therefore, that the two-phase region will show positive thermo-potentials characteristic of the type *A* phase, and that in passing from the defect fluorite-phase to the two-phase region, the thermo-electromotive force of a typical couple, metal/air-ignited oxide/metal, will change sign.

Experiments were made in which the electromotive force of couples of the type chromel/$PrO_{1.83}$/chromel was measured in air over a temperature range 200–1,100° C., the air-ignited oxide being progressively denuded of oxygen as the temperature increased. The accompanying graph shows the temperature variation of the thermo-electromotive force of two such couples.

It is seen that below 780° C. the direction of the thermo-electromotive force indicates electron conduction. It is evident that in this region, like other properties associated with semi-conduction, it is not a material constant, but is variable from specimen to specimen and dependent on past history. At 780° C. it is zero for both specimens, and above this temperature changes to positive values.




Thermo-electromotive force–1/*T* curves for air-ignited material. Curve 1, plate *A*3; curve 2, plate *A*5

It should be pointed out, however, that an explanation of this effect can be found which does not depend upon a phase transition. On the Wilson model of a semi-conductor, it is reasonable to expect that there is a limiting concentration of electrons in the conduction band, above which electrons will assume the nature of positive holes. In air-ignited praseodymia, there are effectively two electrons shared between every $6Pr^{4+}$ cations. This relatively high electron concentration will increase with evaporation of oxygen out of the lattice, and it may be that at 780° C. the limiting electron concentration is reached, when the conduction mechanism will change from one which is electronic to one which is positive-hole in nature. Support for this explanation is given by the small values of the thermo-electromotive forces recorded, which indicate that 'metal-like' conditions exist in the semi-conductor.

I am indebted to Dr. J. S. Anderson for valuable discussion and advice during the course of this work.

R. L. MARTIN

Chemistry Department,
University of Melbourne,
Carlton, N.3.
Sept. 19.

[1] Prandtl, *Z. anorg. Chem.*, **149**, 235 (1925); **239**, 225 (1938).
[2] Marsh, *J. Chem. Soc.*, **15** (1946).
[3] Zintl and Morawietz, *Z. anorg. Chem.*, **245**, 26 (1940).
[4] Wilson, *Proc. Roy. Soc.*, A, **133**, 458 (1931); **134**, 277 (1932).
[5] Pauling, *Z. Krist.*, **69**, 415 (1928).

## Systems of Mutually Immiscible Liquid Layers

JÄNECKE[1] and Lester Smith[2] have described systems of four non-metallic liquid layers in equilibrium. Hildebrand[3] has recently obtained a system of five non-metallic layers (heptane, aniline, water, perfluorokerosene and supercooled phosphorus) and two metallic layers (gallium and mercury). A more easily obtained (and safer) system with five stable non-metallic layers is described below.

Such of the fatty alcohols as are not completely miscible with water are, when perfectly dry, miscible with liquid paraffin; but *iso*butyl (or amyl) alcohol, liquid paraffin, and water together form a three-phase system. Methylene iodide and mercury, added to this, form two further phases.

If the water is replaced by mutually immiscible solutions of ammonia and potassium carbonate (the organic layers being first shaken with excess of the former to saturate them with ammonia), a system of six liquid phases results. These are, from the top downwards: (i) ammonia solution; (ii) *iso*butyl alcohol; (iii) liquid paraffin; (iv) potassium carbonate solution; (v) methylene iodide; (vi) mercury. Gallium would form a further layer above the mercury.

After shaking, the layers separate within a minute. After standing for about a month in a sealed tube at room temperature, the ammonia sinks to third place and then unites with the carbonate layer. This is due to a reaction involving the methylene iodide.

If the water in Hildebrand's system were replaced by solutions of potassium carbonate and ammonia (the other layers having first been saturated with the latter), a system of eight liquid phases would result.

This letter is published by permission of the Chief Scientist, Ministry of Supply.

R. E. Pattle
Chemical Defence Experimental Establishment.
Sept. 23.

[1] Jänecke, *Z. Electrochem.*, **33**, 518 (1927).
[2] Lester Smith, *Nature*, **127**, 91 (1931).
[3] Hildebrand, *J. Phys. and Colloid Chem.*, **53**, 944 (1949).

## South African Stone Age Terminology

In commenting on recent research in South Africa, Mr. Miles Burkitt[1] directs attention to the recognition of the presence of the Magosian Culture "from British Somaliland to the Cape", and adds: "one can only hope that all the many Magosian discoveries in Africa are really Magosian. . . . There is a danger of over-simplification; a culture name can easily become a sort of dustbin into which many different discoveries are thrown."

Anyone handling newly discovered archæological material has to decide whether that material should be assigned to an already recognized culture, or whether it demands a new classification with a new name. Errors of judgment in one direction will lead to the confusion which Mr. Burkitt deplores; errors in the other direction lead to a multiplicity of terms, often half-understood by co-workers, and the separation of things which should not be separated. Both types of error will lead us astray, but over-analysis will take us farther from the truth than will over-synthesis, and is more difficult to correct in the light of later knowledge.

The discovery of industries in South Africa made up of final Middle Stone Age forms in association with Wilton forms was not unexpected, since they fill an obvious hiatus between the Middle Stone Age and the microlithic industries of the Later Stone Age. Since the term 'Magosian' had been coined by Mr. Burkitt for a culture in Uganda which presented precisely the same combination of Middle Stone Age and Wilton forms, it would have been difficult to justify the coining of a new name for the South African discoveries. There may be, and probably are, differences between the Magosian of Magosi and the Magosian of South Africa, for which reason we have meticulously used the term 'South African Magosian' and not simply 'Magosian' for the South African occurrences. The qualifying regional prefix is essential.

It is, of course, possible, as Mr. Burkitt fears, that a few of the industries ascribed to the South African Magosian are, in fact, mixed assemblages of Middle Stone Age and Wilton industries from open sites—in at least one instance I share Mr. Burkitt's misgivings; but there can be no doubt that industries which combine the techniques and types referred to occur from Somaliland to the Cape. This is placed beyond question by my excavations at Ladybrand in the Orange Free State, where sealed cave deposits have yielded three stages of the South African Magosian at a considerable depth under an obvious Wilton industry.

Avoidance of the term 'Magosian' by introducing a new local place-name for these industries in each territory would lead to a situation where we should have perhaps half a dozen names derived from places in the Union of South Africa, Southern and Northern Rhodesia, Kenya, Uganda and Somaliland, all meaning very nearly the same thing!

It should be remembered that workers in Africa have to contend with many special problems of terminology arising from the vast areas with which they are concerned. It was for this reason that the First Pan-African Congress on Prehistory in Nairobi in 1947 appointed a standing Consultative Committee on Terminology, representative of the five major areas of Africa, to assist those who find themselves confronted with the apparent need to introduce new terms.

B. D. Malan
Archæological Survey,
Union Education Department,
University, Milner Park, Johannesburg.
Nov. 30.

[1] *Nature*, **164**, 739 (1949).

Dr. Malan ably defends the use of a place name given to a local stone age industry for describing one occurring hundreds of miles away in a totally different area. He is averse to a multiplicity of local place names where the industries can be shown on typological grounds to be reasonably similar. Of course, he is correct in saying that the multiplicity of local names for cultures occurring in wide-flung areas must lead to confusion when these cultures can be shown to be identical; but my great point is that a study of the typology of the two industries ascribed to the same culture by itself is not always sufficient to determine this with certainty, unless the industries in question are complex and comprise a number of specialized tools. Unless similar industries occur in the intervening districts, errors may easily arise when two somewhat similar industries are ascribed to the same culture, if separated from each other by hundreds of miles. Equally it may happen that two widely separated and not identical industries do belong to the same culture. One may be the product of the culture after a long period of migration, during which time some changes in the typology have taken place. A further difficulty is ever present. A newly discovered culture starts by receiving the place name where it was first identified; for example, the Clacton culture at Clacton. Later the name gets transferred to some typological or technological characteristic of the industry. When we are informed that Clacton flints occur in Uganda, it is no longer suggested that the not very important culture of Clacton somehow reached Uganda; but that folk there used a similar (quite reasonable) method of fracturing flint or other material occurring there.

It is all somewhat confusing for the unfortunate amateur. Personally, I favour the use of place names for cultures only, and that their use as descriptions of techniques should be frowned upon. Where it can be proved beyond cavil that two industries in widely separated areas are the products of the same culture, of course the first-used place name should be employed. But I feel as I grow older an increasing distrust of the typological method by itself. I am therefore inclined to suggest that frequently a multiplicity of local place names, to be sorted out by our successors when more information is available, is the lesser of two evils. Let me say at once that I am not suggesting that Dr. Malan's culture is not a true Magosian. But I am a bit afraid that the not very complicated industry at that insignificant waterhole in Uganda is having to carry a somewhat heavy burden. The whole problem is of great importance and interest, and one is grateful to Dr. Malan for his reasoned letter.

M. C. Burkitt

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Saturday, February 4

TEXTILE INSTITUTE (at the King's School, Macclesfield), at 10 a.m.—Conference on "The Preparation of Continuous Filament Yarns for Weaving and Knitting".

## Monday, February 6

BRITISH WELDING RESEARCH ASSOCIATION (at 29 Park Crescent, London, W.1), at 3 p.m.—Sir Ben Lockspeiser: Opening of the "Research and Production" Exhibition (February 7–February 11).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. L. Boucher: Presidential Address.

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "What Can Usefully be Taught to Students about Ferromagnetism ?" (to be opened by Mr. F. Y. Poynton).

INSTITUTION OF ELECTRICAL ENGINEERS, NORTH-EASTERN RADIO AND MEASUREMENTS GROUP (at King's College, Newcastle-upon-Tyne), at 6.15 p.m.—Discussion on "Control and Measuring Equipment—Electronic versus Non-Electronic Apparatus".

INSTITUTION OF ELECTRICAL ENGINEERS, MERSEY AND NORTH WALES CENTRE (at the Liverpool Royal Institution, Colquitt Street, Liverpool), at 6.30 p.m.—Dr. J. S. Forrest: "The Performance of the British Grid System in Thunderstorms". (To be repeated on Thursday, April 13, at the Plaza Cinema, Swansea, at 6 p.m., and on Tuesday, April 18, at Queen's University, Belfast, at 6.45 p.m.)

CHEMICAL SOCIETY, OXFORD BRANCH (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Dr. H. Irving: "Analytical Chemistry—Science or Art ?". (All Fellows are invited.)

## Tuesday, February 7

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. C. R. Bailey: "Rockets".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. F. E. Zeuner: "The Stone Age of Peninsular India".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.15 p.m.—Dr. L. C. Thomson: "Visual Physiology".* (Further Lectures on February 14 and 21.)

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. G. N. Patchett: "A New Precision A.C. Voltage Stabilizer"; Mr. E. Bradshaw and Mr. M. Z. Tanyeloglu: "An Instrument for the Measurement of Rate of Change of Power-System Frequencies".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. D. Hicks: "Scientific Control in the Coal Industry".*

INSTITUTION OF ELECTRICAL ENGINEERS, EAST MIDLAND CENTRE (at Loughborough College, Loughborough), at 6.30 p.m.—Mr. G. T. Winch: "The Measurement of Light and Colour". (To be repeated on Monday, February 20, at the Liverpool Royal Institution, Colquitt Street, Liverpool, at 6.30 p.m.)

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Prof. T. H. Oliver: "Venice, the Dolomites and Engadine".

CHEMICAL SOCIETY, EDINBURGH SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the University Medical Buildings, Teviot Place, Edinburgh), at 7 p.m.—Prof. W. E. Garner, F.R.S.: "Some Aspects of Solid Reactions".

INSTITUTION OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Dr. L. Bateman: "Oxidation of Rubber".

## Wednesday, February 8

CHEMICAL SOCIETY, NORTHERN IRELAND SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, the SOCIETY OF CHEMICAL INDUSTRY and the SOCIETY OF DYERS AND COLOURISTS, at the Queen's Hotel, Belfast), at 7.30 p.m.—Mr. E. F. Eaton: "Colours in Food".

INSTITUTION OF THE RUBBER INDUSTRY, WEST OF ENGLAND SECTION (at the George Hotel, Trowbridge), at 7.45 p.m.—Mr. H. Smith: "Press and Mould Design".

## Thursday, February 9

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. D. R. Newth: "Eggs".*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Succulent Plants" (to be opened by Dr. E. M. Delf, Prof. T. A. Bennet-Clark and Mrs. Vera Higgins).

CHEMICAL SOCIETY, HULL SECTION (joint meeting with UNIVERSITY COLLEGE SCIENTIFIC SOCIETY, in the Science Lecture Theatre, University College, Hull), at 6 p.m.—Dr. H. W. Thompson, F.R.S.: "Some Recent Applications of Infra-Red Spectroscopy". (To be repeated on Wednesday, March 22, at the Engineers' Club, Albert Square, Manchester, at 6.30 p.m.)

CHEMICAL SOCIETY, BRISTOL SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Department of Chemistry, The University, Bristol), at 7 p.m.—Prof. M. Stacey: "Studies of some Organic Fluorine Compounds".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Acton Technical College, High Street, Acton, London, W.3), at 7.30 p.m.—Dr. E. Lester Smith: "Vitamin $B_{12}$".

PHARMACEUTICAL SOCIETY, MANCHESTER, SALFORD AND DISTRICT BRANCH (in the Council Chamber, Houldsworth Hall, Manchester), at 7.45 p.m.—Mr. A. F. Plowright: "Pharmaceutical Education with Special Reference to Recent Changes".

## Friday, February 10

OIL AND COLOUR CHEMISTS' ASSOCIATION, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Mr. N. D. P. Smith: "The Use of the Electron Microscope in Paint Problems".

CHEMICAL SOCIETY, BIRMINGHAM SECTION (in the Main Chemistry Lecture Theatre, The University, Edgbaston, Birmingham), at 4.30 p.m.—Sir Ian Heilbron, F.R.S.: "Fifty Years of Organic Chemistry".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting, followed by Annual General Meeting.

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (in the Council Chamber, College of Technology, Manchester), at 6 p.m.—Dr. W. Summer: "Television and the Human Eye".

INSTITUTE OF INDUSTRIAL ADMINISTRATION, MANCHESTER CENTRE (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. M. Markowe: "Human Relations in Industry".

PLASTICS INSTITUTE (at the Engineers' Club, Albert Square, Manchester), at 6.45 p.m.—Mr. Maidwyn Jones: "Polythene".

ROYAL STATISTICAL SOCIETY, SOUTH WALES GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Agricultural College, Usk), at 7 p.m.—Mr. M. Sampford: "The Application of Statistical Method in Agriculture".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Mr. J. Davidson Pratt: "The Economics of the Fine Chemical Industry".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT BOTANIST (with Honours degree in botany or agricultural botany) at Sourhope Experimental Farm, Yetholm, Kelso—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (February 11).

GRADUATE BIOCHEMIST to teach microbiology, chemistry and physics in relation to food—The Secretary, Smithfield College of Food Technology, Eagle Court, St. John's Lane, London, E.C.1 (February 11).

SENIOR ASSISTANT IN THE TECHNICAL COLLEGE, Bradford, to give general assistance to the Principal, and to participate in the teaching of industrial administration and management—The Director of Education, Town Hall, Bradford (February 11).

ASSISTANT LECTURER IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Leeds 2 (February 20).

TECHNICAL OFFICER II (with a good Honours degree in geography or geology) in the Technical and Scientific Register, for work in the employment service of the Register dealing mainly with graduates in geography, geology and psychology—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.311/49A (February 20).

ASSISTANT ANALYTICAL CHEMIST (male) in the Government Analyst's Laboratory, Salisbury—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (February 25).

DIRECTOR, CENTRAL BUILDING RESEARCH INSTITUTE, Roorkee—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 474E (February 27).

ASSISTANT PHYSICIST (with good Honours degree in physics) IN THE PHYSICS DEPARTMENT of the Sheffield National Centre for Radiotherapy—The Secretary, Broom Cross, Tree Root Walk, Sheffield 10 (February 28).

PHYSICIST at a Ministry of Supply Research Establishment near London, for duties primarily concerned with technical administration of large group of scientific and ancillary staff working on physical and mathematical problems associated with explosives and armaments—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.13/50 (February 28).

ELECTRICAL ENGINEER, or PHYSICIST with knowledge of some aspect of the application of electronics (other than radio), in the N.C.B. Central Research Establishment at Stoke Orchard, near Cheltenham—The National Coal Board, Establishments Branch (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT.185 (March 3).

SUPERINTENDENT OF THE RESEARCH GLASSHOUSES (should possess a degree in horticulture or its equivalent, with good experience of modern glasshouse management)—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 4).

RESEARCH CHEMIST FOR THE PLANT PROTECTIVE CHEMISTRY SECTION, to work with other chemists and biologists on chemical control of pests and diseases of fruit and hops—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 10).

CHAIR OF ELECTRICAL ENGINEERING at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 13).

LECTURER IN PSYCHOLOGY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 13).

DERBY CHAIR OF ANATOMY—The Registrar, The University, Liverpool (March 18).

LECTURER IN STATISTICS in the Department of Mathematics in the United College—The Secretary, The University, St. Andrews (March 31).

SENIOR LECTURER or LECTURER IN PHARMACOLOGY in the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (March 31).

I.C.I. RESEARCH FELLOWSHIPS for research in physics, chemistry, biochemistry, engineering, metallurgy, pharmacology, chemotherapy, or related subjects—The Secretary, Board of Research Studies, The Old Schools, Cambridge (April 30).

LECTURER IN ENTOMOLOGY, and an ASSISTANT LECTURER IN ZOOLOGY—The Registrar, The University, Nottingham.

SENIOR ASSISTANT IN PHARMACEUTICS in the Welsh College of Pharmacy, Cardiff Technical College—The Director of Education, City Hall, Cardiff.

SENIOR LECTURER IN THE DEPARTMENT OF AIRCRAFT PROPULSION—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

ELECTRICAL ENGINEERS by the Central Electricity Board, Federation of Malaya, qualified for (*a*) Electrical Generation (Ref. No. M.N.25014/3B) or (*b*) Electrical Distribution (Ref. No. M.N.25016/3B)—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting the appropriate Ref. No.

ELECTRICAL ENGINEERS in the Electrical Department, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27326/16.

CIVIL ENGINEER for the investigation of water supplies in Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/139.

EXECUTIVE ENGINEERS in the Public Works Department, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27322/149.

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# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Department of Scientific and Industrial Research: Radio Research. Special Report No. 19: Lateral Deviation of Radio Waves reflected at the Ionosphere. By W. Ross. Pp. iv+32. (London: H.M. Stationery Office, 1949.) 9*d*. net. [2411

Air Ministry: Meteorological Office. Professional Notes, No. 98: Rainfall in East Scotland in relation to the Synoptic Situation. By R. F. M. Hay. (M. O. 420r.) Pp. 18. (London: H.M. Stationery Office, 1949.) 6*d*. net. [2411

University of Durham: King's College, Newcastle-upon-Tyne. Academical Year 1949–1950. Pp. 873. (Newcastle-upon-Tyne: King's College, 1949.) [2811

The Field Scientific Liaison Work of Unesco. (Publication 361.) Pp. 68. (London: H.M. Stationery Office, 1949.) 1*s*. 6*d*. net. [2811

Animal Health Trust. Third Report, 1st July 1948–30th June 1949. Pp. 76. (London: Animal Health Trust, 1949.) [2811

Mushroom Research Association. Report for the Years 1946–1948. Pp. 71. (Peterborough: Mushroom Research Association, 1949.) 10*s*. [2811

British Hat and Allied Feltmakers Research Association. Second Annual Report of the Director of Research for Year ending August 1949. Pp. 12. (Leeds: The University, 1949.) [2811

British Institute of Management. Occasional Papers No. 3: Setting up a new Government Department; an Account of the Formation of the Ministry of National Insurance. By H. V. Rhodes. Pp. 48. (London: British Institute of Management, 1949.) 2*s*. 6*d*. [2811

Major Diseases and Competitors of the Cultivated White Mushroom. By Fred. C. Atkins. Pp. 24. (Peterborough: Mushroom Growers Association, 1949.) 5*s*. [2811

British Council. Report for 1948–1949. Pp. 147. (London: British Council, 1949.) [3011

Department of Scientific and Industrial Research. Wartime Activities of the Road Research Laboratory. Pp. iv+24+12 plates. (London: H.M. Stationery Office, 1949.) 1*s*. 3*d*. net. [3011

Selected Government Research Reports. Vol. 2: Paints. Pp. iv+70. (London: H.M. Stationery Office, 1949.) 5*s*. net. [112

Annual Report on the Progress of Rubber Technology. Vol. 12, 1948. Edited by Dr. T. J. Drakeley. (Published for the Institution of the Rubber Industry.) Pp. vi+108. (Cambridge: W. Heffer and Sons, Ltd., 1949.) 12*s*. 6*d*. net; to Members, 4*s*. 6*d*. net. [112

British Internal Combustion Engine Research Association. Sixth Annual Report, 1st April 1948–31st March 1949. Pp. 19. (Slough: British Internal Combustion Engine Research Association, 1949.) [112

British Electrical and Allied Industries Research Association. Technical Report, Reference C/T101: Large-Scale Generation of Electricity by Wind-Power; Preliminary Report. By E. W. Golding. Pp. 16. (Leatherhead: British Electrical and Allied Industries Research Association, 1949.) 1*s*. 6*d*. net. [512

East Malling Research Station. Annual Report 1948. Pp. 162+20 plates. 10*s*. Supplementary Annual Report: General Development and Activities, 1948. Pp. 30. (East Malling: East Malling Research Station, 1949.) [512

Man the Tool-Maker. By Kenneth P. Oakley. Pp. v+98+2 plates. (London: British Museum (Natural History), 1949.) 2*s*. 6*d*. [512

Birkbeck College. Calendar for the Year 1949–50. Pp. 169. (London: Birkbeck College, 1949.) [512

Reports on the Progress of Applied Chemistry. Vol. 33, 1948. Pp. 742. (London: Society of Chemical Industry, 1949.) [512

Abstracts of Dissertations approved for the Ph.D., M.Sc., and M.Litt. Degrees in the University of Cambridge during the Academical Year 1947–1948. (Published by Authority.) Pp. 132. (Cambridge: At the University Press, 1949.) [712

## Other Countries

Departamento Forestal del Ecuador. Publicacion No. 4: Algunas consideraciones ecologicas sobre la introduccion de especies forestales exoticas a los paises andinos. Por Prof. Dr. M. Acosta Solis. Pp. 8. (Quito: Editorial 'Ecuador', 1949.) [2411

Comité International des Poids et Mesures. Procès-verbaux des séances, Deuxième Série, Tome 21, Session de 1948. Pp. viii+108+T146+x. (Paris: Libr. Gauthier-Villars, 1948.) [2811

Les récents progrès du système métrique 1948: Rapport présenté à la neuvième Conférence générale des Poids et Mesures réunie à Paris en Octobre 1948. Par Albert Pérard. Pp. 52. (Paris: Libr. Gauthier-Villars, 1949.) [2811

Comptes rendus des séances de la neuvième Conférence générale des Poids et Mesures réunie à Paris en 1948. Pp. 127. (Paris: Libr. Gauthier-Villars, 1949.) [2811

Kongelige Danske Videnskabernes Selskab. Biologiske Skrifter, Bind 6, Nr. 3: Über den Lebenszyklus und die postembryonale Entwicklung zweier dänischer Proturengattungen. Von S. L. Tuxen. Pp. 50. (Kobenhavn: Ejnar Munksgaard, 1949.) 10 Dan. kr. [2811

Canada: Department of Mines and Resources; Mines, Forests and Scientific Services Branch. Geological Survey, Bulletin No. 12: Jurassic Formations of Maude Island and Alliford Bay, Skidegate Inlet, Queen Charlotte Islands, British Columbia. By F. H. McLearn. Pp. v+19. 25 cents. Geological Survey, Memoir 251: McConnell Creek Map-area, Cassiar District, British Columbia. By C. S. Lord. (No. 2488.) Pp. v+72. 25 cents. (Ottawa: King's Printer, 1948–1949.) [2811

Canada: Department of Mines and Resources; Mines and Geology Branch, Bureau of Geology and Topography. Geological Survey, Economic Geology Series No. 1: Minerals of Canada. By Officers of the Geological Survey. (No. 2478.) Third edition. Pp. xi+357. (Ottawa: King's Printer, 1947.) 75 cents. [2811

Canada: Department of Mines and Resources; Mines, Forests and Scientific Services Branch. National Museum of Canada, Bulletin No. 114 (Biological Series, No. 38): Birds of Lake Mistassini and Lake Albanel, Quebec. By W. Earl Godfrey. Pp. iv+43. (Ottawa: King's Printer, 1949.) 25 cents. [2811

Research Council of Israel. Types of *S. typhosa* in Israel and the Near East and their Epidemiological Significance. By L. Olitzki and M. Shelubsky. Pp. 24. (Jerusalem: Research Council of Israel, 1949.) 150 mils; 3*s*. [2911

Southwest Research Institute: Division of Oceanography and Meteorology. Publication 1: Bibliography on Offshore Petroleum Developments. By Emory N. Kemler. Pp. 20. (Houston, Texas: Southwest Research Institute, 1949.) [2911

United Nations: Department of Social Affairs. Bulletin on Narcotics. (Quarterly.) No. 1, October. Pp. 64. (Lake Success, N.Y.: United Nations; London: H.M. Stationery Office, 1949.) Annual subscription, 2 dollars. [2911

Biological Abstracts. Report for 1948. By John E. Flynn. Pp. 12. (Philadelphia: University of Pennsylvania, 1949.) [2911

Memoirs of the Geological Survey of India. Vol. 77: Catalogue of Publications of the Geological Survey of India and Index of Geological Maps, up to March 1946. Pp. iii+129. (Calcutta: Geological Survey of India, 1948.) 8 rupees; 13*s*. [2911

Jubilee Publication in the Commemoration of Prof. H. Yabe's Sixtieth Birthday. Vol. 1. Pp. xxvii+612+32 plates. Vol. 2. Pp. iii+613–1251+plates 33–52. Memorial Lectures given in honour of the Commemoration of Prof. H. Yabe's Sixtieth Birthday. Pp. 58. (Sendai: Tohoku University, 1939–1941.) [112

Companhia de Diamantes de Angola. Publicacoes Culturais, No. 4: Tentative Study of the Pleistocene Climatic Changes and Stone-Age Culture Sequence in North-Eastern Angola. By Dr. L. S. B. Leakey. Pp. 82. (Dundo, Angola: Museu do Dundo, 1949.) [512

Bulletin of the Raffles Museum, Singapore. No. 20: An Annotated Checklist of the Birds of Malaya; an Annotated List of the Birds occurring, or known to have occurred, in the Territories of the Federation of Malaya and the Colony of Singapore. By C. A. Gibson-Hill. Pp. 299. (Singapore: Raffles Museum, 1949.) 5 dollars; 12*s*. [512

Bose Research Institute. Annual Report for the Year 1948–1949. Pp. 23. Recent Advances in our Knowledge of Nerves. Tenth Sir J. C. Bose Memorial Lecture delivered on the 30th November 1948. By Prof. K. N. Dahl. Pp. 21. (Calcutta: Bose Research Institute, 1949.) [512

## Catalogues

Wray Binoculars. Pp. 14. (Bromley: Wray (Optical Works Ltd., 1949.)

Oscillograph Type D–365–A. (Bulletin B.641.A.) Pp. 2. Inductance Bridge Type A–181–A. (Bulletin B.644.A.) Pp. 2. Frequency Bridge Type D–101–A. (Bulletin B.645.A.) Pp. 2. (Beckenham: Muirhead and Co., Ltd., 1949.)

Automatic Voltage Regulators with Electronic Control. (London: Zenith Electric Co., Ltd., 1949.)

Secondhand Books in Philosophy, Psychology and Theology. (Catalogue No. 519.) Pp. 30. Book Bulletin, No. 9. Pp. 16. (Cambridge: Bowes and Bowes, Ltd., 1949.)

Old, Rare, and Fine Books and Papers on Zoology, Natural History, Science, Botany, etc. (Catalogue No. 4.) Pp. 54. (College Park, Md.: Biological Book Service, P.O. Box 401, 1949.)

Siemens Engineering Bulletin. No. 246/7: 33,000 volt Submarine Cable in one continuous length across the Solent to the Isle of Wight. Pp. 12. No. 248/9: The New Type 100 High Speed Relay with Double Changeover Action. Pp. 4. (London: Siemens Brothers and Co., Ltd., 1949.)

Notes on 'Oxoid' Culture Media. Pp. 6; with Samples of Nutrient Broth and Nutrient Agar in tablet and granule forms. (London: Oxo, Ltd., 1949.)